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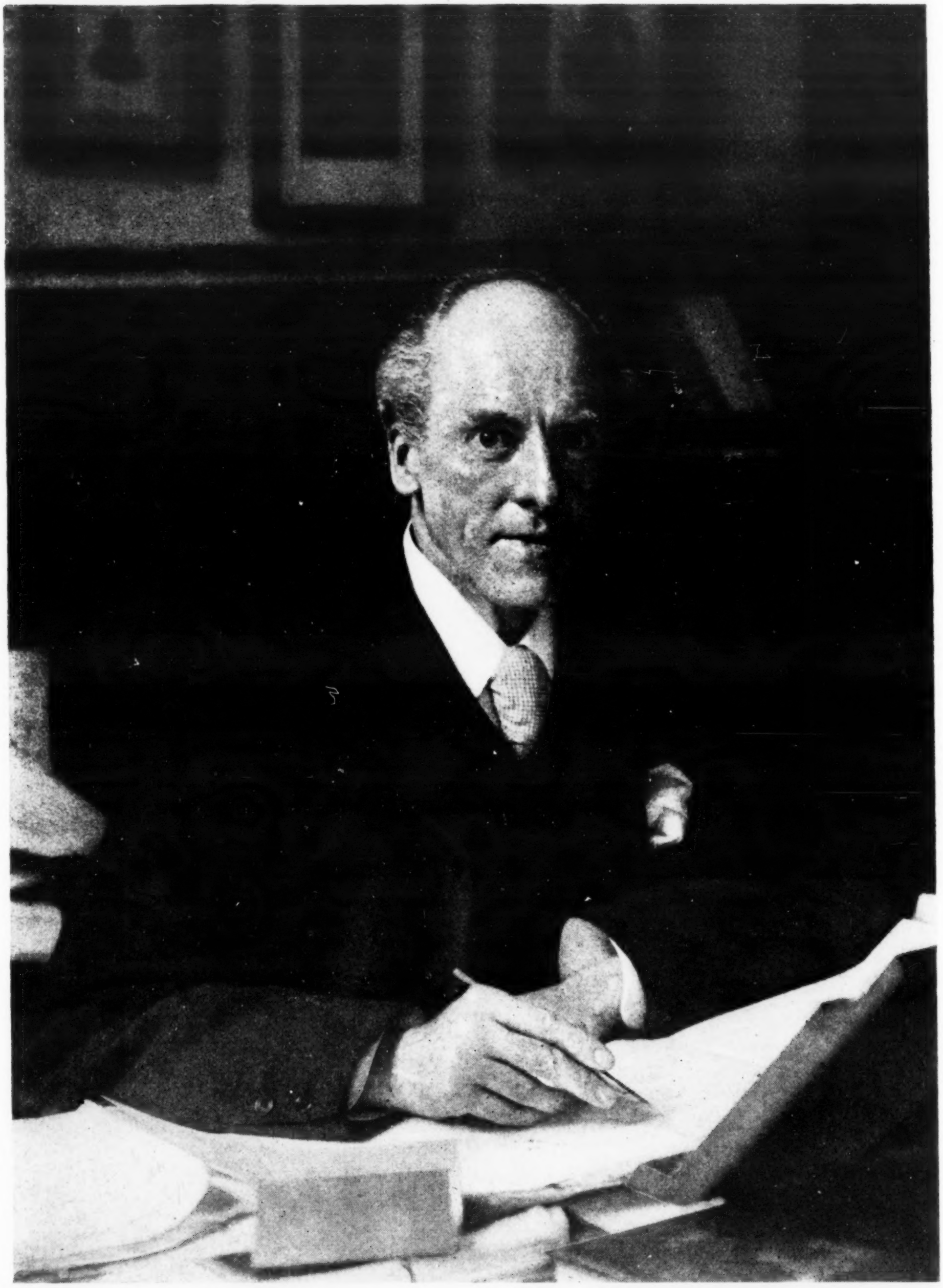

KARL PEARSON

The name of the director of the Galton Laboratory of National Eugenics, University of London, is probably familiar to all readers, but few know what he looks like. For many years he has been the leader of a movement to apply statistical methods to biological problems, and he and his students have made many notable contributions to the study of heredity and variation. Since the outbreak of the war, Prof. Pearson's biometric work has been largely suspended, the staff of his laboratory having for some time placed its services at the command of the government and devoted itself to keeping track of unemployment in Great Britain. (Frontispiece.)

PEAR BREEDING

Valuable Group of Fruit Trees Lends Itself Readily to Cross-Pollination, and Valuable Results Are Possible—Considerable Time Needed—Methods of Operation

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HYBRIDS are easily made in the pear genus (in which many botanists now include the apple, quince, medlar, etc.), and many of these hybrids offer valuable commercial possibilities. As trees of this kind are accessible to nearly every one in the temperate regions of the world, it is a particularly good group for amateur plant-breeders to work with, provided they are not in a hurry.

The European pear (*Pyrus communis*) is found throughout southern Europe and Asia, being indigenous as far east as Kashmír. It has been cultivated since the dawn of history, and selection of the best, with such cross-pollination as has been done by nature, seems to be responsible for the production of such superb pears as those which are known in Europe as the *beurre* type, and which are represented in the United States by the Bartlett.

Pears of this kind were among the first fruit trees imported by the early settlers in North America. Some time before the middle of the nineteenth century a very distinct species, the Chinese Sand Pear (*P. sinensis*) was introduced. The fruit of this species is considered good by the Chinese and Japanese, but it is hard and lacking in flavor, and full of stone-cells. When one's teeth crunch into these, it is not difficult to understand why this variety got the name Sand Pear.

Peter Kieffer, of Roxborough, Philadelphia, an Alsatian gardener, who died in 1890, grew some of these Sand Pears, according to L. H. Bailey, "and sold the seedlings as ornamental trees, for this species is of very distinct and handsome growth and the fruit is ornamental and fragrant. Alongside the Sand Pears were Bartletts. Among one of the batches of seedlings from the Sand Pear he noticed a plant with different foliage, and this he saved. Its fruit was found to be superior to the Sand Pear, and it was introduced as the Kieffer. The Kieffer pear is now very popular in many parts of the country because of its great vigor, healthfulness, productiveness and the keeping quality of its fruit. In point of quality the fruit is distinctly inferior, but it meets the demands of the market and is an excellent fruit for canning."

There is no doubt that the Kieffer, which is second only to the Bartlett in popularity in the United States, is a hybrid of the Bartlett and the Sand Pear. While the circumstances of its origin, as told by Bailey, would not be conclusive on that point, there are plenty of other crosses of a similar nature, many of which are in the trade. The Le Conte is perhaps the best known of these hybrids, after the Kieffer.

ROOM FOR NEW VARIETIES

One who undertakes pear-breeding need not expect to produce, at the first attempt, a hybrid that will supplant the Kieffer, although many connoisseurs have declared that it would not be hard to surpass the quality of that popular variety. There is need of varities that will be hardy and disease-resistant, and that will extend the fruiting season, and any one who undertakes the task of pear-breeding intelligently and persistently has a chance to succeed.[1]

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[1] A cross between the pear and quince was described by Dr. L. Trabut in the last issue of this Journal. The Office of Seed and Plant Introduction, U. S. Department of Agriculture, Washington, D. C., has brought in many wild species of Pyrus for breeders, and any experimenter could probably secure specimens from it; but as is pointed out in the present article, more is to be

"In the improvement of any fruit," says W. R. Ballard of the Maryland Experiment Station,[2] "an intimate knowledge of varieties is essential to intelligent effort. Such information should include not only the adaptability of varieties to climatic conditions, habit of growth, season, productiveness, character and quality of fruit, but should also include as far as possible information concerning disease resistance and historical data in regard to parentage. The great majority of varieties grown in this country are undoubtedly of hybrid origin. This is due to the promiscuous cross-pollination carried on by bees and other insects. This fact makes the value of a variety for breeding purposes somewhat problematical since many characters show up in the progeny which cannot readily be detected in the parents. This hybrid nature, however, works to the advantage of the breeder of orchard fruits for wide variation occurs in the first generation, so that he does not have to wait until the second generation for such results, as would be the case were he working with pure strains. Investigations here and at other stations indicate that the greatest improvement is to be secured by using for breeding purposes only the best of the varieties now in existence. Only occasionaly is it necessary to depart from this rule in order to utilize some particular character of an otherwise inferior variety.

"Since pollination can be done only during a comparatively short blooming period, it is essential to be thoroughly prepared for work when the time comes. There is more or less variation in the time of blossoming of different varieties, although in abnormal seasons all varieties have been known to bloom at about the same time. Advantage can often be taken of this variation by using the early bloomers as the male parent. This enables one to collect pollen in workable quantitites before the buds of the later varieties are ready to be pollinated. Weather conditions are also more likely to be favorable for pollinating work at this later period.

MAKING POLLINATIONS

"Normally the anthers burst and the pollen is shed shortly after the blossom opens. This usually takes place early in the day. In cross-pollination it was formerly customary to break off recently opened blossoms and brush the stigmas of the emasculated buds with the opening anthers. There was always danger in this method that bees or other insects had already visited the flowers leaving a deposit of foreign pollen in the blossom used for pollinating. Where the purpose was simply to get variation without regard to parentage, this method worked very well in a small way, but where a study is to be made of the laws of inheritance more accurate methods must be followed.

"A simple method used by the author to insure a good supply of pollen is to gather a number of buds which are just ready to open but not far enough advanced to allow the entrance of insects. This would usually be about a day before they would normally open. By grasping the petals between thumb and forefinger, they can easily be rubbed off, together with anthers. These are then collected on a newspaper and after the loose petals and other waste materials have been sifted out, the anthers are transferred to glass dishes (petrie dishes are excellent for this purpose) and placed in a moderately warm dry atmosphere. The anthers will soon burst open releasing the pollen grains. When the pollen becomes dry it is protected from moisture until needed. Handled in this way it may be kept for several days, although it is always advisable to use it as soon after being collected as convenient. Should doubt arise as to it viability, a test of its germinating power is made by placing a small quantity of

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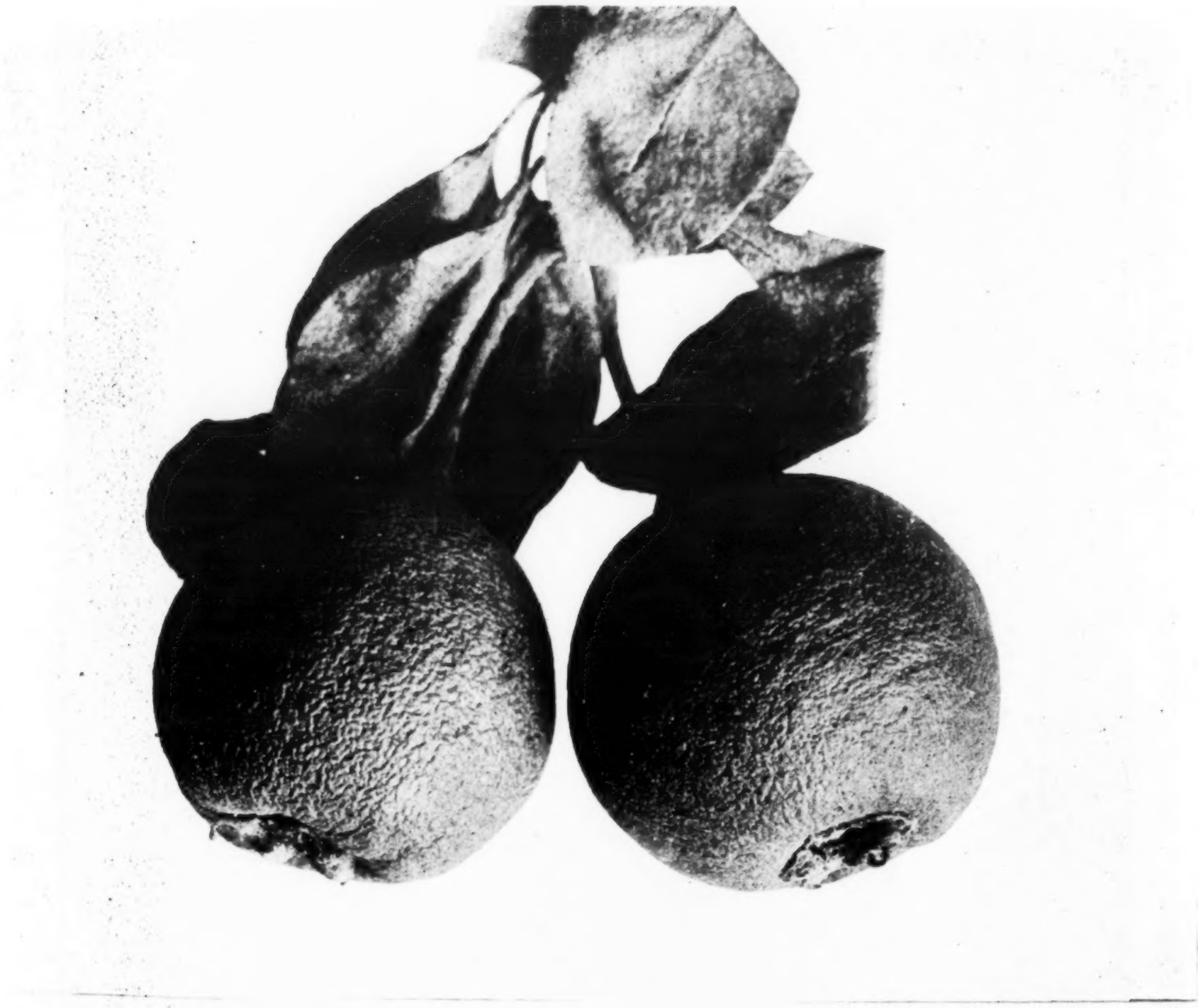
expected by crossing varieties that have already been improved. The wild species are of value mainly as stocks for grafting, a Chinese species known as *Pyrus davidiana* having proved particularly valuable by its hardiness and vigor.

[2] Ballard, W. R., Methods and Problems in Pear and Apple Breeding. Maryland Agricultural Experiment Station, Bulletin No. 196, College Park, Md., April, 1916.



THE BARTLETT PEAR AND ITS ANCESTOR

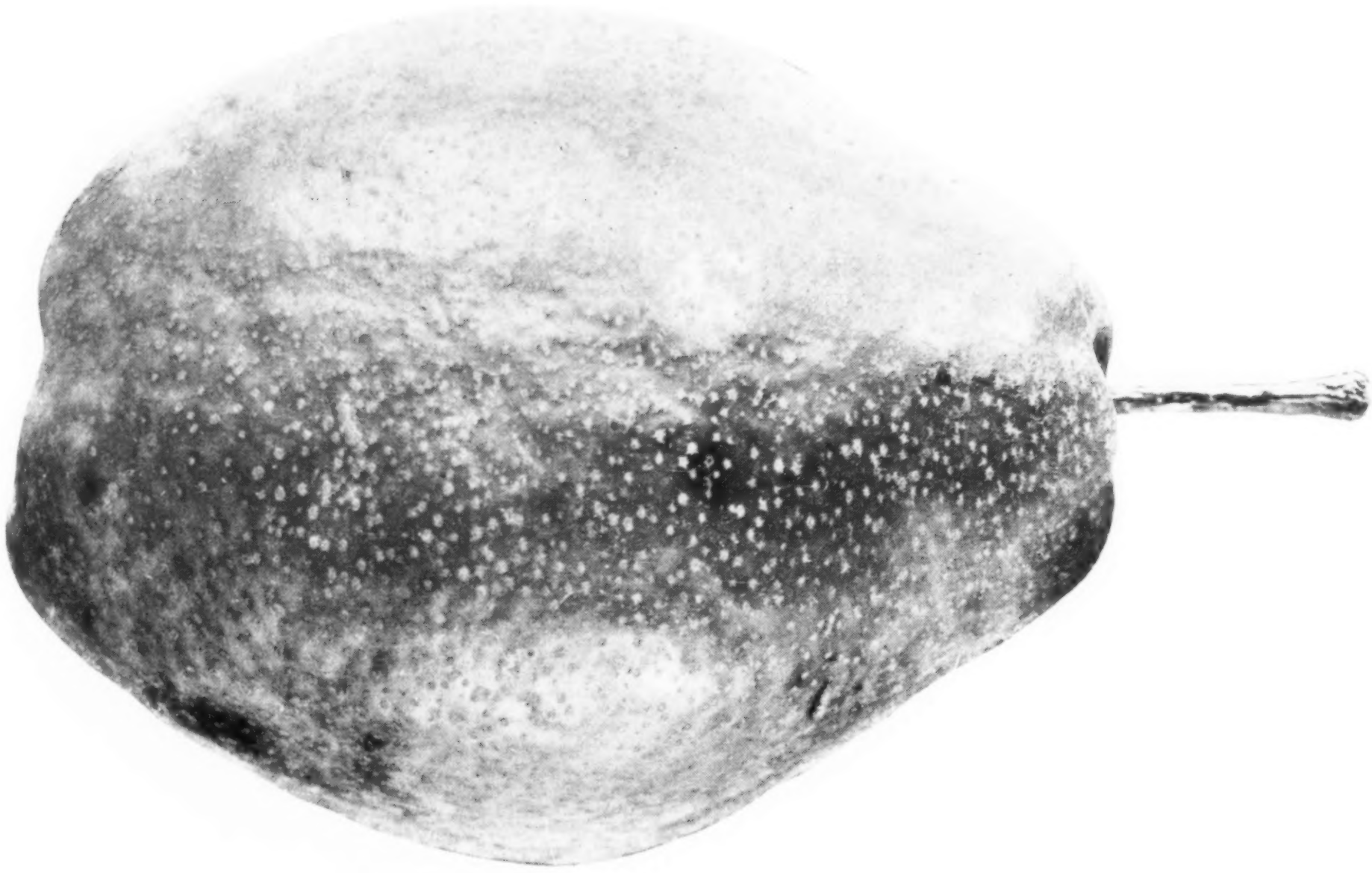
The wild pear which grows throughout the southern parts of Europe and Western Asia was brought under cultivation in prehistoric times, and has evolved into the delicious fruit of the Bartlett type, a small specimen of which is shown below. The wild fruit, shown above, is not actually the *Pyrus communis* which is the reputed ancestor of the Bartlett, but the Snow Pear (*P. nivalis*), the fruit of which is practically identical. The leaves differ, but the differences are so slight that some botanists have considered the Snow Pear nothing more than a variety of *P. communis*, a good photograph of which was not obtainable. Photograph (natural size) from the U. S. Department of Agriculture. (Fig. 1.)

THE CHINESE SAND PEAR

This hard-fruited little species is common in China and Japan, where it has been considerably improved in size but not very much in flavor. It was introduced to the United States as an ornamental tree, and accidental crosses with Bartlett Pears resulted in some valuable new varieties which are widely grown in the United States. Photograph (natural size) from the U. S. Department of Agriculture. (Fig. 2.)

pollen in a 2% solution of sugar and keeping it at a moderate temperature. If upon examination under a microscope after a few hours, the pollen grains are found to have germinated and sent out their pollen tubes, it is usually safe to use the remaining pollen for crossing. Each kind of pollen is carefully labelled in order that no uncertainty may arise as to its source.

"In order to effect a cross the buds to be pollinated should first be emasculated, so that self-fertilization may not take place. The following method has been used by the writer for several years with pears and apples with excellent results. The bud is held firmly between the thumb and forefinger of the left hand. Emasculation is then accomplished expeditiously by inserting



THE KIEFFER, A VALUABLE CHANCE HYBRID

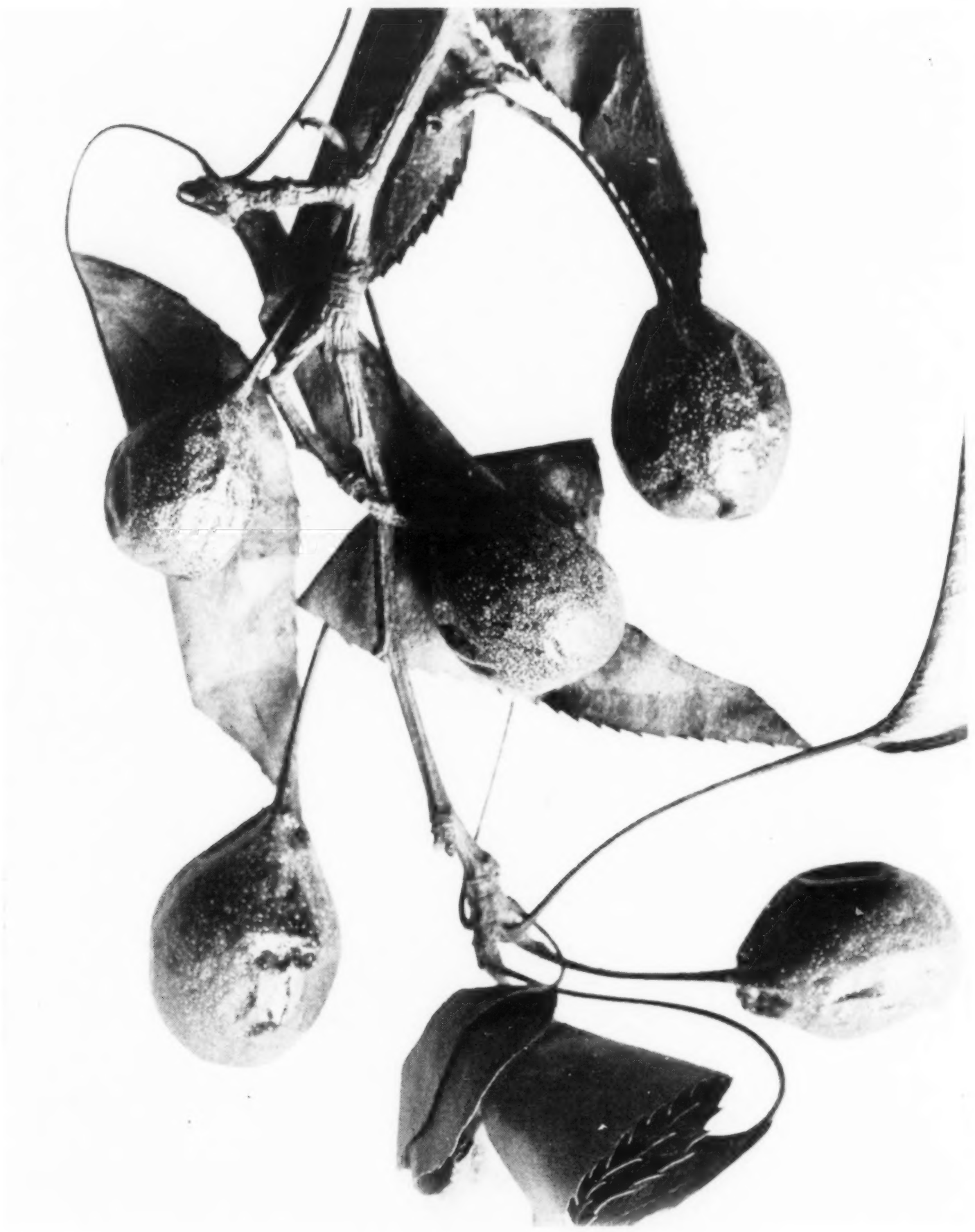
The popular Kieffer pear, a fine specimen of which is here shown, natural size, originated as an accidental cross in a Philadelphia nursery half a century or more ago. Its parents were the Bartlett pear and the poor Chinese Sand Pear shown in Fig. 2. The Le Conte and several other less-known varieties have come from the same sort of hybridization. Although many epicures have condemned the quality of the Kieffer, it holds its place as one of the most widely grown varieties in the United States. Photograph from the U. S. Department of Agriculture. (Fig. 3.)

a well-sharpened scalpel into the side of a bud just below the calyx. Then by giving it a quick upward jerk, the whole corolla is removed, carrying with it all the anthers. Pear buds are especially easy to work in this manner, but in the apple the abundant pubescence soon dulls the scalpel necessitating frequent sharpening for the best results.

FEW BUDS REMOVED

"Fruit buds of the pear and apple are borne in clusters of six or more. Ordinarily only one or two of these buds set fruit and come to maturity. In hybridizing work the question arises as to the number of buds in the cluster which should be emasculated and pollinated. The central bud develops previously to the others so that it is safer to remove it. The best results have followed the working of the majority of the buds in the cluster, since the emasculation can be done in about the length of time it would take to remove the extra buds, and pollination requires very little longer time. Sometimes several clusters are close together and may be enclosed in a single bag. As many as eleven fruits of the Seckel pear have been secured under one sack in this way.

"Until recently it has been customary to emasculate the buds, cover at once with a paper sack and leave for a day or so until the stigmatic surface reaches a receptive condition before pollination is done. The writer has found that equally good results are secured by pollinating at the time of emasculation, provided this operation is delayed until the buds are nearly ready to open. Pollen will remain on the stigma in good condition until it can germinate in the nectar which is secreted on the stigmatic surface. This eliminates the extra work of removing



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PREPARING TO POLLINATE PEARS

The flower may be held as shown above, and its top jerked off with a sharp scalpel. This removes all the pollen-bearing parts of the flower, but leaves the stigma and ovary. There is then no danger of self-pollination, which would result in a mix-up of heredity. A corolla which has been removed is shown in the upper right-hand part of the picture; a little to the left, below it, is a cluster of flowers which have been emasculated and are now ready to be cross-pollinated. The pollen must be secured from other flowers by removing the buds a day before they open. Four such buds are shown in the photograph. The anthers are taken from them and kept in some convenient way; the glass petrie dish full of anthers, shown at the bottom of the above picture, is much used. The tag illustrates how crosses should be marked to avoid confusion. Further details of the operations are given in the text. Photograph from Maryland Experiment Sta. Bull. No. 196. (Fig. 4.)

the sacks for pollination and replacing them A camel's hair brush is frequently recommended for applying the pollen but the writer has found the tip of the finger to answer the purpose more satisfactorily."

After pollination the buds are covered with manilla paper sacks and carefully labelled. Time is saved by giving the labels simply a serial number for identification. Other data of the cross are kept in a notebook. In recording the cross it is customary to write the name of the female parent first, followed by that of the male parent, *e. g.*, Seckel x Kieffer.

SETTING OF THE FRUIT

"Not much is yet known about the sexual affinities of our cultivated varieties of pears and apples. Unfavorable seasonal conditions and some unknown factors, probably of a physiological nature, make this subject a confusing one. The writer has often noted trees loaded with fruit blossoms which set an extremely small amount of fruit, notwithstanding the fact that what are generally considered favorable weather conditions for pollination prevailed. Such failures do not appear to be due to lack of pollen, for even where buds are thoroughly pollinated artificially, the percentage of fruit set seems to correspond with that of the tree as a whole. It is true that certain crosses generally give better results than do others. Pears generally set a higher percentage of fruit than apples whether pollinated naturally or artificially. Of the total number of pear buds pollinated in our work, the percentage which set fruit was 24.2, while that of the total number of apple buds pollinated was 9.9. The variation in the different crosses is quite noticeable, some consistently failing to set fruit, while others set well. One of the most remarkable sets of fruit was recorded in the spring of 1910 when 651 fruits of the Seckel pear set, out of a total number of 807 buds pollinated with Kieffer pollen. This amounts to about 80.6 %. Over a series of years, however, the average drops to 37.8 %.

"After the June drop the paper sacks are removed and a record made of the number of fruit set. The fruit is then covered with bags made of mosquito netting which allows a good development of the fruit and prevents loss, should it mature and fall off before being picked. In cases where specimens have fallen out of the sacks accidentally, the scar which results from removing the calyx in emasculation often furnishes a convenient mark of identification. A few instances were noted where the development in the paper sacks was hindered by infestations of aphids. Protected from their natural enemies the aphids multiplied enormously until the sacks contained great masses of the insects.

GATHERING THE SEED

"As the fruit ripens it is gathered and the seed removed when fully matured. The number of seeds produced by different varieties varies considerably, a fact which may often be turned to advantage by choosing prolific varieties as female parents.

"The seeds are kept in a dry place until time to plant. After trying various methods the writer has found that one of the most satisfactory ways of handling the seed is to plant them in thumb pots or flats in light well-drained soil and place them in a cold frame early in the fall. There is always a certain percentage of loss of pots from freezing and bursting so that flats are more economical. To prevent getting the seed from the different crosses mixed, the greatest care must be exercised. No one, who has not worked with things of this sort, can appreciate how easy it is to get the labels or seeds misplaced.

"Early in March the seeds are removed to the greenhouse and are given gentle heat. Germination usually takes place rapidly under such conditions. It is essential to water with great care at this stage to avoid loss from damping-off fungi. Slugs seem to be extremely fond of the young seedlings and they should be guarded against. A trail of some such material as soot, lime or kainit surrounding the pots or boxes

makes a good deterrent. Seedlings in flats are potted off after the first two or three true leaves appear and are then transplanted to the nursery row when danger of frost is over.

ELIMINATION OF UNDESIRABLES

"Since fruit trees are grown primarily for their fruit, it would be highly desirable from an economical standpoint to eliminate undesirable seedlings at an early age. After considerable correspondence with plant breeders, the writer reached the conclusion that, in the present state of our knowledge of the subject, no satisfactory basis of elimination has yet been worked out. In view of the importance of determining whether there are correlated characters which can be used for that purpose, it seems desirable to grow all seedlings up to the fruiting age in order that tree and fruit characters may be compared. The prevailing opinion seems to be that the best results are obtained from seedlings showing a close resemblance to the smooth appearance of our improved forms. In regard to this point, Joe A. Burton, who is in charge of the apple breeding work of the Indiana State Horticultural Society, states that he inquired of a prominent plant breeder if anything could be done in selection. Mr. Burton writes:

> The following is his reply: "Prominent buds, large, smooth, regular, glossy leaves, large leaf stems, short distances between buds and a compact sturdy look, are the best indications of a good apple among seedlings." I was greatly pleased with this information because it coincided with what I and my friends already believed. So on one occasion when the Horticultural Board of the State, all experienced horticulturists, visited the Experimental Orchard, I asked them to select each a tree that he thought most promising. One tree all agreed would surely be grand. As they came into bearing nearly every tree was a sweet variety, and the special tree a very small worthless variety. Not a selected tree was of any worth. I had refrained from cutting out trees that I was sure were worthless, because I had had no experience. It was well that I did. We did not know how to select. . . . Consider a few well-known varieties. Grimes and Rambo are thorny. Rambo is especially unpromising in bud appearance. Benoni, the king of summer varieties, is very unpromising both in tree and bud. Jonathan grows so straggling that nurserymen don't like to grow it.

"At best it is a long time to wait for seedling trees to come into bearing. Various expedients have been tried to shorten this period. A number of seedlings were top-worked on dwarf trees but the results were not encouraging The top-working entailed a good deal of labor, and where several kinds were placed on the same tree it was almost impossible to keep track of them. Besides this many of the seedlings fruited almost as early on their own roots.

"Girdling was another method tried. The first plan used was to remove a ring of bark but some of the wounds did not heal readily and later it was found more satisfactory to check the flow of sap by wrapping the branch with a strand of fine wire. When this was done on trees 5 or 6 years old about the last of June very good results were secured. One drawback to girdling is the production of numerous water sprouts just below the point girdled. These water sprouts are very susceptible to the fire blight. Summer pruning helps somewhat in controlling them, but it must be done with care or it will only serve to spread the blight around. Frequently the first blossoms appear on the terminal shoots so it seems desirable not to prune these back severely. Even with these expedients, however, one can hardly expect any very great results in breeding work with pears and apples in less than ten or twelve years."

Tobacco That Will Burn

"Fire-holding capacity" is the basis for breeding tobacco in Germany, as described by D. Hoffmann in *Fühling's Landwirthschaftliche Zeitung* (64, pp. 366–371). The duration of glow of 150 unfermented leaves was found to range from 10 seconds to the complete incineration of the leaf. The capacity for holding fire appears to be an inherited character, but there are some difficulties connected with producing leaves that burn as well as is desired.

FECUNDITY AND STAMINA

Very High Egg Yields Do Not Seem to Result in Any Deterioration of Stock, and the Birds Produced in Such Strains Are up to the Average in Vigor—Selection Necessary[1]

A. A. Dunnicliff, Jr.
New South Wales

THE danger signal has been raised by more or less authoritative critics in various parts of the world that the striving for higher and higher egg production, and breeding from hens of great fecundity, can only result in degeneration of the constitution of the stock and consequent disaster to the breeder.

Egg-laying competitions have been pointed to as exercising a dangerous influence in this direction by fostering and stimulating the breeder's efforts to "climb the ever-climbing wave" of high records, at the expense of the vitality of the layers and the stamina of their progeny. Now, in New South Wales, where this work has been in continuous progress longer than in any other part of the world, we know that the attainment of high records has never been subordinated by the controlling committees to practical and utilitarian considerations, as the restrictions as to quality, size of eggs, and weight of the pullets testify. The great records obtained in these competitions have been produced on the plain ration of the ordinary poultry-farmer, without any forcing foods or adventitious aids, consequently there is nothing in them that is fictitious or beyond the scope of the commercial poultry-keeper. They, therefore, offer a sound basis for the consideration of the question at issue. The second and third year tests have provided unique opportunities for observation as to the relation between fecundity and stamina. Further, the following up of breeders' results from competition hens of great prolificness furnishes facts which dissipate theories as to the inroads which heavy laying makes upon the constitution of the hen and her power to transmit stamina to her progeny.

RECORDS OF CHAMPIONS

It is instructive to trace the results of breeding from hens that have put up high records in these competitions. Take the pen of White Leghorns which won the second two-years' test with 1,474 eggs in the first year and 1,150 eggs in the second year, and that which won the fourth two-years' test with 1,324 eggs in the first year, and 1,045 in the second year. Both belonged to the same owner and were bred on the same lines. These hens, I am assured by the purchaser of them, proved entirely satisfactory as breeders, both as regards fertility and the constitutional vigor of the progeny. The stock I have seen from these hens fully bears this out. Mated to cockerels of a strain with many years' conspicuous competition performances, the tendency to weakness which has been pointed to as a concomitant of high fecundity could be looked for in both lines of blood did it exist. On the contrary, even in the fourth and fifth generations the resultant stock shows a high average robustness that leaves nothing to be desired, a fact that is emphasised by pens of the direct progeny in the fourteenth and current (fifteenth) competitions.

[1] This paper was awarded first prize by the committee of management in connection with the eighth annual conference of poultry farmers, held at the Hawkesbury (N. S. W.) Agricultural College on June 17, 1916. It is here reprinted from the *Agricultural Gazette* of New South Wales, July 3, 1916, Vol. XXVII, part 7, pp. 507–510.

Another example may be cited in the White Leghorn hens which won the 1912-13 competition with 1,461 eggs, and the following two-years' test with 1,091 eggs in their second year without replacement of a bird. These hens subsequently in the breeding pen reproduced in the constitutional vigor of their progeny the inherent vitality which sustained their great laying in the competition. It was the owner of these hens who, with other birds of precisely the same blood, achieved a world's record in the 1914-15 single-pen test. The four best hens in that group, with certified individual records of 267, 270, 270, and 288 eggs, when used for breeding last season, gave every evidence that constitutionally they had not suffered under the strain of this great production, which represented eight times their own weight in eggs. The owner and breeder of these exceptionally prolific hens emphatically states: "I notice absolutely no deterioration in stamina or constitution in the progeny. I never had a healthier or more vigorous lot of youngsters. They hatched well and reared well." Six of the daughters of these hens are competing in the present competition, and physically they compare in every respect with their mothers.

Again, the results of breeding from the three best hens that gave the highest returns in the 1913-14 single-pen test have been similarly satisfactory. In the first season the fertility was good, the chickens were sturdy, and they developed to maturity with a high average in full possession of soundness and vitality. A cockerel from them was mated back to these hens, and observation in my own and other yards shows that there is no evidence of physical deterioration in either pullets or cockerels of this second generation. Instances of this sort could be multiplied were it necessary.

ONE ADVERSE CASE

It may be asked, have there been any failures as breeders amongst these high competitive producers? I have only met with one case that appeared to point in that direction. This was in connection with a pen of Chinese Langshans which won the fifth annual competition and the first two-years' test, and whose score of 1,481 eggs stood as the record for eight years in these competitions. The hatching and rearing results from these hens in the hands of the purchaser of the pen were certainly disappointing, but their owner assured me that the fault was his. He was at that time quite a novice, and, in his own words, "the hens never had a chance." He has since maintained that same line of blood direct from these hens with results that have given him complete satisfaction.

The available evidence warrants the conclusion that a hen is not to be regarded as a doubtful transmitter of stamina to her progeny because she is the proved possessor of the factor of fecundity in a high or exceptional degree. There is certainly a field for investigational work in the closer study of prepotency in regard to these hens of extreme fecundity, and possibilities for extending the educational side of the competitions in this direction, in co-operation with the owners, might well be a matter for consideration by the controlling authorities. But, as already indicated, the following up, as it were, of the hens after they have been tested at Hawkesbury College, has shown how theoretical and fallacious is the contention that great laying makes great inroads upon the stamina of a hen, and that for this reason, in order to maintain constitutional vigor in the stock, preference should be given to the medium layer in selecting breeding birds. This term "medium" layer is a very vague one. We see some old world self-styled experts advocating the 150-egg hen as the ideal embodiment of constitution required to fulfil the functions of mother of the flock, while others go so far as to pronounce the 180-egg hen a safe proposition. In this country, since the competitions have focussed attention upon all these practical questions, the 200-egg hen has become so commonplace that any possessor of a good laying strain would

ridicule the idea that the hen that has the stamina to sustain laying at the 200-egg rate is constitutionally unfit to efficiently perform her reproductive functions. Logically the same reasoning applies to the 250-egg hen, which is no more a *rara avis* nowadays than was the 200-egg hen in the early years of these competitions. And why stop at the 250-egg layer? Why, indeed, since the actual breeding results show that the danger of decadence does not lie even in the 288-egg hen. Rather is there more reason to argue from the opposite standpoint, that sustained heavy laying is proof of a correspondingly high standard of constitutional soundness.

LOW DEATH RATE

In the second and third year competitions we have had opportunities of observing how the heavy producers of the first year have carried through their second and third seasons. The facts are plain and convincing that there has been no abnormal "cracking up" consequent upon high first-year production. On the contrary, the percentage of deaths is below the average among such hens. For instance, if we analyse the three-years' competition figures and take the ten pens that made the best scores in the first year (all over 1,300 eggs), we find that the percentage of deaths from all causes in the subsequent two years was 11.6, while if we take the ten pens with the lowest first-year records it is seen that the two following years gave 16.6% of deaths. The hens that have broken down constitutionally after exceptional laying in the first year have been few and far between.

Warnings have been sounded that continual breeding for higher egg returns would inevitably produce ovarian disorders and weakness, but it can be definitely stated that the competitions of the past few years supply no evidence whatever of any such signs of an increase in constitutional deterioration. This is not to say that hens do not break down under the strain of heavy laying; but their first year will almost invariably find out their weakness in this respect. It is only in accord with scientific expectation that hens which have maintained uniformly high laying throughout the first-year competition stage, have sustained their vitality, moulted well, and have entered their second season in vigorous condition, fit to fulfil all the requirements of the breeder. This of itself is a strong argument in favour of breeding from second-year or older hens that have proved their vitality and productive capacity.

POINTS FOR SELECTION

The object of this paper is not only to oppose a misleading line of reasoning, but to impress upon breeders one of the obvious guiding lessons of these competitions. This is that the hen of high fecundity is not only a safe, but an eminently desirable unit in the breeding-pen, provided other rational and practical considerations in selection and mating are observed. It is not enough that the breeding hen should be a good layer or the descendant of a line of high producers; physique is essential. Therefore, first regard must be paid to the outward and physical signs of vigor and constitution, and to reasonable conformity to the standard size and type of the breed. The doctrine that selection of vigorous and well-developed birds is the first principle in breeding has been preached since the earliest days of which literature has record of poultry culture. There is no rule more widely known and less practiced. On the majority of farms there are to be seen weedy, narrow-chested specimens with no depth of body and little pretension to type included in the breeding pens, simply on account of their ancestry, or because they are so-and-so's strain, or that they have some supposed external mark of the layer. It is all too common, too, to see pullets of this class being tested out in their first year, with a view to being used later as breeders—pullets which, no matter what their trial performance, could never be worth a place in a well-balanced pen of breeders.

It is impossible to keep up the stamina and quality of the flock, much less improve it, while these primary rules of breeding are apathetically ignored, and until there is a more general observance of these esentials there can not be any general improvement in these characters in the flocks of the great body of commercial or utility poultry-keepers. The study of the individual hens in conjunction with their performances in the single-pen tests of the last three years at Hawkesbury College has furnished invaluable lessons in the correlation of type, physique, and fecundity, and no poultry-farmer should neglect to take the fullest advantage of the opportunity for observation provided by the 420 hens which are being tested in single pens this year. The living object-lesson will be there with the record of the laying of each as the key. It constitutes an educational demonstration capable of practical application in their business as poultry-farmers, such as is not at the disposal of breeders in any other part of the world.

Prussia Subsidizes School Teachers with Children

According to the *Pädagogische Zeitung* the Prussian government, by a decree of October 20, 1915, has made tax concessions, based on the number of their children, to the teachers in public schools. The premium goes as high as 2,100 marks ($525), in which the dwelling or allowance for dwelling is not included. For the first and second child under 15 years, 6 marks; for each additional child 3 marks a month are allowed. These sums will be paid from the national treasury, the local authorities (*Gemeinden*) not being called on for any contribution; so that the latter will be able in this way to stop discriminating against teachers with large families. It is to be hoped that this subsidy will be continued and, if possible, increased after the war, especially for the third and fourth child, so that it will be financially possible for the teachers to abandon the two-child system which has become so widespread among them. As the teachers certainly represent a physical and mental selection from the race, a step in the direction of national eugenics would thus be taken.—Fritz Lenz in *Archiv für Rassen- und Gesellschafts-Biologie*, XI, p. 560. (Published in Munich, Germany.)

Increased Activity in German Eugenics

German plans for counteracting the cacogenic results of the war have several times been mentioned in this JOURNAL. We are now informed of the organization of a *Bund zur Erhaltung und Mehrung der deutschen Volkskraft* with the object of "safeguarding the soundness of present and future generations." It was organized at Halle a. S. with about 1,000 members, and has sent out a number of leaflets to the military forces, on such subjects as alcoholism, venereal diseases, and the need for a high birth-rate. In Berlin a *Deutsche Gesellschaft für Bevölkerungspolitik* has been organized under the initiative of Geh. Regierungsrat Prof. Dr. Julius Wolf, with similar objects. Its program includes prevention of infant mortality, education in mothercraft, rural colonization, and similar indirect methods, as well as more direct propaganda. It announces that it will have nothing to do with "lukewarm researches and half-measures." Its leading spirit appears to be Dr. Albert Moll, a biologist internationally known.

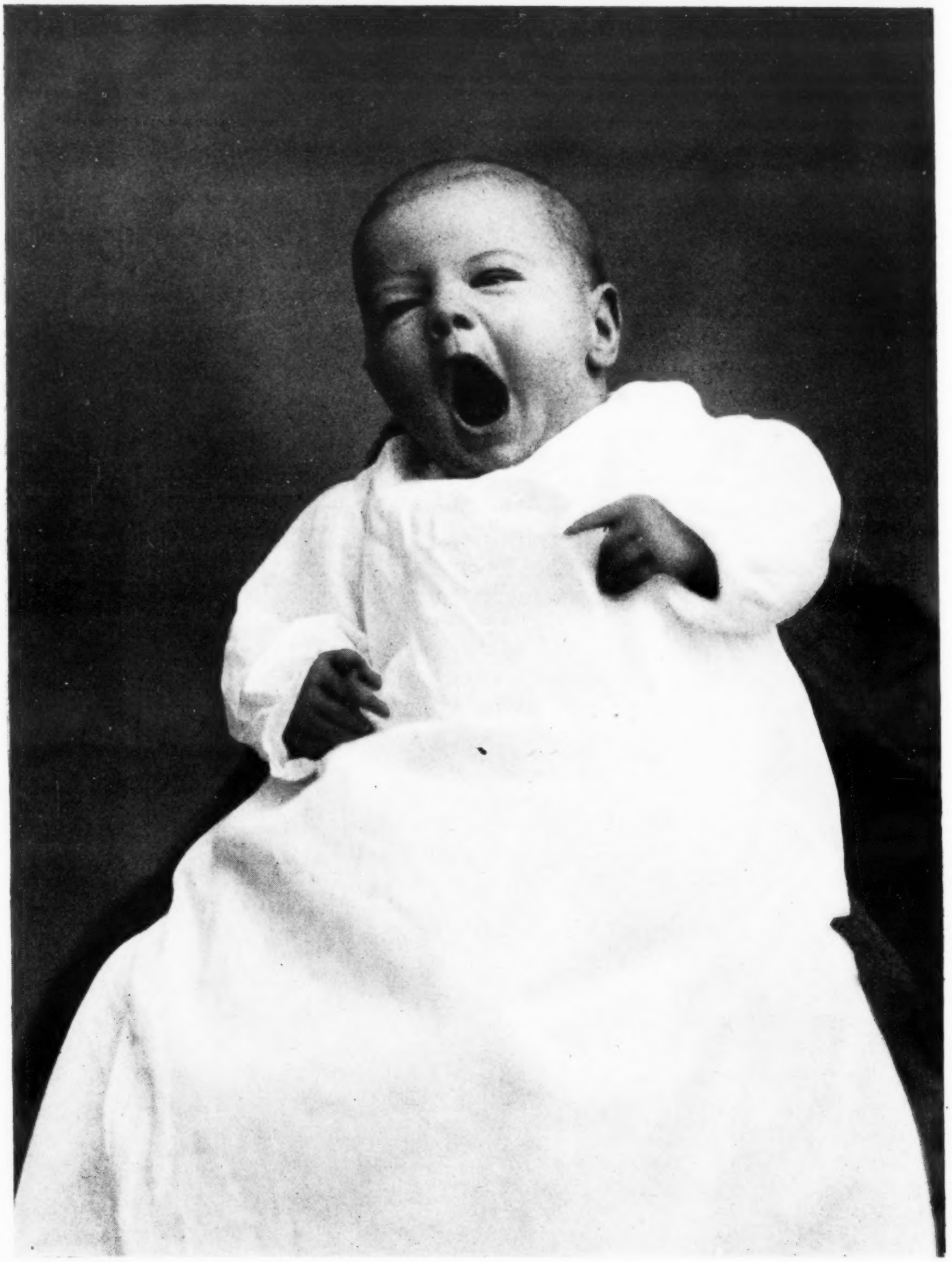
AN APOLOGY FOR YAWNING

YAWNING is commonly said to be a means of ventilating the lungs when they need it. Everyone knows that it is an involuntary act, and often excited by seeing some one else yawn; the real purpose of the act, however, has been very little studied. Prof. F. H. Pike, of the College of Physicians and Surgeons, Columbia University, New York, was asked for his opinion in regard to the evolutionary origin of yawning, and has sent the following remarks, with a warning that they are partly fact and partly hypothesis.

"Luciani in his *Human Physiology*, vol. 1, p. 438, speaks of a deep inspiration as a part of the general process of yawning. He regards it as the external expression of ennui, drowsiness, hunger, and the like, but it does not seem to me that the ventilation of the thorax is the primary object of yawning. On our present views of the nature of the stimulus to respiration, the ventilation of the thorax keeps pace with the changing hydrogen ion content of the blood. An increase in the concentration of the hydrogen ions is accompanied by an immediate increase in the depth or rate of the respiratory movements. There is normally a deeper inspiration than usual occurring every few breaths, and it does not seem probable that there is a sufficient accumulation of carbon dioxide in the blood under any ordinary conditions to require any extreme effort such as yawning would indicate if its main purpose were to ventilate the lungs. A little vigorous exercise will remove the immediate cause of yawning, but it will also result in a greater ventilation of the thorax and lungs than occurred during yawning.

MUSCULAR MOVEMENTS

"Yawning, in a state of nature, involves certain attendant movements and sounds that are absent in the human subject, after a course in a young ladies' finishing school or any similar institution. The dog gives a sort of whine and stretches his other muscles, particularly those of the fore legs, as well as those of the head and jaws. I am more and more inclined to regard yawning as an expression of a state of approaching fatigue, very much analogous to the other stretching movements of muscles in general. It may be a sort of involuntary exercise to keep one awake until a safe place for sleeping may be found. There is always a little quickening of the faculties after a deep yawn, and this is more pronounced if there is an attendant stretching of the muscles. One might imagine that the impulse to sleep might begin to come upon an animal while still out in the open, and that, if no warning sign were present, he might lie down in the open and go to sleep in a place exposed to attack from enemies. The continued yawning may be sufficient to keep him awake until he can reach a place of safety. This particular kind of utility may be lacking in civilized man, but the whole mechanism persists unchanged. To a certain limited extent, yawning might be regarded as a vestigal function if regarded from this point of view alone. But I am not sure that yawning has ceased to be useful to civilized man. The onset of yawning may interrupt a process which might otherwise be carried to a harmful degree. A student begins to yawn in the evening, and, unless he resorts to some measures to overcome his drowsiness, the interruption to his work is likely to become so great that he seeks relief in sleep. If he employ measures to drive away his drowsiness, such as the use of strong coffee, a walk around the block, or other similar things, he may be able to go on working, but he is pretty certain later on to feel, more severely than ever, the effects of fatigue, and he may suffer great injury if he persists too long in disregarding these warning signs of nature.



A WARNING FROM NATURE

Yawning is commonly said to be a means of ventilating the lungs, but ventilation appears really to be a very small part of the act. It seems more likely that it is a warning of drowsiness and need of sleep. On this hypothesis it could easily be shown to be useful in natural selection. Suppose an animal traveling in the open is suddenly overcome with fatigue and the need of sleep: if he went to sleep on the spot he would be exposed to enemies and perhaps perish. The yawn warns him to look for shelter and rest, and there seems to be a slight quickening of the faculties after yawning which aids the animal to get to a place of safety. The act may still be of use to man in a similar connection, warning him when he has worked long enough and needs to seek repose. This explanation is hypothetical, as the subject has been little studied: but yawning appears at any rate to be a very primitive function, going back far beyond the mammals in the scale of evolution. Photograph from the Nursery Studio, Washington, D. C. (Fig. 5.)

"I think Luciani is right in regarding yawning as an expression of drowsiness, but I believe also that too much emphasis has been placed on the factor of ventilation of the lungs. As a matter of fact, if one yawns widely, there is a total cessation of the movements of the thorax and diaphragm during the period when the mouth is most widely open. This I attribute to the stimulation of the endings of the glossopharyngeal nerve in the pharynx and uvula by the stretching of these portions of the alimentary tract at that time. It is well known that stimulation of the glossopharyngeal nerve will stop all respiratory movements immediately. Such a cessation normally occurs during swallowing. At the moment anything touches the uvula, respiration ceases immediately. One can feel the stretching of the pillars of the fauces and of the pharynx and uvula, or, more correctly, the part of the soft palate immediately to each side of the uvula, when the mouth is widely open in yawning."

Not only is yawning a very primitive adaption (if, indeed, it be an adaptation) but it appears to go back to a remote stage of evolution, perhaps far below the age of mammals. On this point Dr. Pike remarks:

"In thinking over the matter superficially it appears that the primitive respiratory neuro-muscular mechanism is the part particularly concerned. In fishes, the respiratory system involves the musculature of the mouth and possibly of the pharynx, and the nerves concerned are the fifth, seventh, ninth, tenth and twelfth cranial. The diaphragm and the phrenic nerve have not yet made their appearance, and the intercostal nerves and muscles are not concerned in the respiratory movements. That is what I mean by the primitive neuro-muscular respiratory mechanism. The muscles of the face and pharynx are involved in yawning, and the fifth, ninth, tenth and twelfth cranial nerves are also involved. I do not know where in the animal scale yawning first appears, but I should imagine that we might expect it in all the mammals, and possibly in some of the poikilothermal forms. It seems to be present in birds. In some respects, it approaches the type of respiration that is seen in cases of approaching death. In such circumstances, we have again the participation of the primitive neuro-muscular respiratory mechanism. The mouth is opened widely, often with a quivering or unsteady movement, and the thorax does not participate to the same extent as in normal respiration. The movements of the thorax may persist, altered in rhythm, to be sure, but nevertheless present, during yawning. I think that this is further evidence of the fact that yawning is related to the primitive mechanism."

Why Do Women Become Mothers?

"The facts, shorn of sentiment," says Mrs. Leta S. Hollingworth in the July *Am. Journ. Sociology*, "are: (1) The bearing and rearing of children is necessary for tribal or national existence and aggrandizement. (2) The bearing and rearing of children is painful, dangerous to life, and involves long years of exacting labor and self-sacrifice. (3) There is no verifiable evidence to show that a maternal instinct exists in women of such all-consuming strength and fervor as to impel them voluntarily to seek the pain, danger and exacting labor involved in a high birth-rate." The pressure of insidious forces set at work by certain "radiant centers of social control" has made women bear children in the past, she thinks, but she considers that her sisters are now on the eve of being emancipated, and that henceforth they will bear few children, unless they get "adequate compensation, either in money or in fame."

RELIGION AND BIRTH CONTROL

ANTAGONISM of the Roman Catholic church toward the "birth control" movement is well known. This antagonism is based on theological grounds, but it has frequently been pointed out that the result, whether the church has the fact in mind or not, will be to give the church a slowly increasing preponderance in numbers, in any community where the population is made up in part of Catholics and in part of Protestants.

The Church of Latter-Day Saints of Jesus Christ, popularly known as the Mormon church, has taken a similarly antagonistic stand on birth control. Theological objections are raised against it; but in this case what may be called the eugenic aspect, the problem of altering the relative proportions of different classes in a population, is clearly seen and acknowledged.

In the July issue of the *Relief Society Magazine*, an official publication issued at Salt Lake City, five of the twelve elders who make up the supreme council of the organization state their views on birth control. Elder Rudger Clawson says that it is sinful to restrict the number of children in a family, continuing:

"Woman is so constituted that, ordinarily, she is capable of bearing, during the years of her greatest strength and physical vigor, from eight to ten children, and in exceptional cases a larger number than that. The law of her nature so ordered it, and God's command, while it did not specify the exact number of children allotted to woman, simply implied that she should exercise the sacred power of procreation to its utmost limit."

Elder George F. Richards writes: "My wife has borne to me fifteen children. Anything short of this would have been less than her duty and privilege."

The eugenic view of the subject is most clearly seen by elder Joseph F. Smith, Jr., who points out:

"The first great commandment given both to man and beast by the Creator was to be fruitful and multiply and replenish the earth; and I have not learned that this commandment was ever repealed. Those who attempt to pervert the ways of the Lord, and to prevent their offspring from coming into the world in obedience to this great command, are guilty of one of the most heinous crimes in the category. There is no promise of eternal salvation and exaltation for such as they, for by their acts they prove their unworthiness for exaltation and unfitness for a kingdom where the crowning glory is the continuation of the family union and eternal increase which have been promised to all those who obey the law of the Lord. It is just as much murder to destroy life before as it is after birth, although man-made laws may not so consider it; but there is One who does take notice and his justice and judgment is sure.

"I feel only the greatest contempt for those who, because of a little worldly learning or a feeling of their own superiority over others, advocate and endeavor to control the so-called 'lower classes' from what they are pleased to call 'indiscriminate breeding.'

"The old Colonial stock that one or two centuries ago laid the foundation of our great nation, is rapidly being replaced by another people, due to the practice of this erroneous doctrine of 'small families.' According to statistics gathered by a leading magazine published in New York, a year or two ago, the average number of children to a family among the descendants of the old American stock in the New England States, was only two and a fraction, while among the immigrants from European shores who are now coming into our land, the average family was composed of more than six.

"Thus the old stock is surely being replaced by the 'lower classes' of a sturdier and more worthy race. Worthier because they have not learned, in these modern times, to disregard the

great commandment given to man by our Heavenly Father. It is indeed, a case of the survival of the fittest, and it is only a matter of time before those who so strongly advocate and practice this pernicious doctrine of 'birth control' and the limiting of the number of children in the family, will have legislated themselves and their kind out of this mortal existence."

It is proper to point out that birth control is not, as the public seems to suppose, an integral part of the eugenics propaganda. Many eugenicists advocate it; many others oppose it. In either case, it must be regarded as a fact with which eugenics must deal. If one section of a community limits the number of births, and another section does not, it is easy to calculate how soon the latter section will supplant the former, and there are plenty of object lessons such as Mr. Smith cites, in the old colonial stock of New England

A RELATIVE MATTER

The eugenicist, of course, is more interested in the quality than in the quantity of the population. The quantity is important only in a *relative* way. In opposition to Mr. Smith and other people without adequate knowledge of biology, the eugenicist holds that there is a difference in the inherent quality of various sections of the population, and that if an inferior section multiplies much more rapidly than a superior section, the result will be very serious from the standpoint of national efficiency and racial progress.

Precisely such a result has taken place in the United States during the past half-century.

It is unquestionable that the number of births has been much limited in the economically most efficient sections of the population of the United States, and very little limited in the least efficient sections.

It is also unquestionable that the spread of the birth control propaganda in the "lower classes" is at the present time very rapid. Whether or not one approves of that spread, it is certain that the birth-rate in those classes is likely to fall, thus checking the very serious *differential* nature of the present birth-rate.

If, at the same time, eugenics can succeed to some extent in increasing the birth rate among the socially most valuable sections of the community, then the present demonstrable deterioration of the American stock, as a whole, will gradually become less menacing.

Some New Water-Lilies

Most of the water-lilies commonly grown in gardens are chance hybrids. The Missouri Botanical Garden has started systematic breeding work with them, on the one hand to purify some of the strains and on the other hand to produce more desirable hybrid combinations. One Nymphaea has already been produced by four generations of inbreeding which bears only pink flowers, the blue having been eliminated altogether. A hybrid of a night-blooming and day-blooming species has been secured which has the advantage of remaining open longer than ordinary day-flowering species. It is stated that water-lilies are easily crossed, and many amateurs might work with them.

Yak Increasing in Canada

In 1909 the Duke of Bedford gave six yaks to the Canadian government. They are now at Banff, Alberta, and have increased to fourteen. The Canadians hope to make them useful as the foundation of a breed of hardy cattle for the north, just as the American Government is planning in Alaska. The latter experiment was described in the JOURNAL OF HEREDITY for January, 1916 (Vol. VII, p. 48), where an illustration was published.

FORGOTTEN BUD VARIATIONS

Early Orange Growers Found Many "Sports" but did not Recognize Their Significance—Origin of New Varieties—Great Care Needed in Propagation to Get only the Most Desirable Variations

L. B. Scott

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THE work which A. D. Shamel, of the Office of Horticultural and Pomological Investigations of the U. S. Department of Agriculture, has done in demonstrating the variations existing within standard citrus varieties has awakened practical citrus growers at least to a realization of the great individual tree differences in their own plantings and also to the surprising frequency with which bud sports occur in standard citrus varieties.

The investigational work and observations made by members of the staff in California, Florida, the Gulf States, Brazil and Cuba have shown that all citrus varieties in every section have this tendency to break up into a number of different strains. These strains are found occurring as whole trees, as limb sports and as individual fruit sports. It is most interesting in this connection to note that some of the old citrus pioneers of thirty years ago observed striking instances of bud variations, but unfortunately were unable to correlate the observations which they made or to realize that they had within their grasp a principle which has since been demonstrated by Mr. Shamel to be of vital importance to all citrus growers.

Even a casual perusal of the old files of the Office of Horticultural and Pomological Investigations will show that the old horticulturists, both in Florida and California, were attempting to explain the variations which they observed. As a rule, a sporting fruit was generally explained as having been caused by cross-fertilization. An example of such an explanation is contained in the following extract of a letter from E. H. Hart, Federal Point, Fla., February 10, 1887, addressed to Prof. H. E. Van Deman, Pomologist of the United States Department of Agriculture:

"I send you today as per enclosed shipping receipt a box of oranges setting forth the contrasts between their normal condition and after having been subjected to fertilization with pollen from the Navel orange. These ought to prove conclusively the effect of hybridizing upon the fruit as well as the seed. You will observe not only striking modifications in shape but also in the flavor. The varieties most clearly resembling the Navel in habit of growth and outlines of fruit are much more readily affected except perhaps in the case of *Citrus nobilis*, which although the very antipodes of the Navel structurally as well as geographically, nevertheless mixes with it more often than any. It is somewhat singular too that propinquity does not always favor the mixture as trees at a little distance are more often affected than when both kinds have been grafted onto one stock."

The tendency of all citrus varieties to throw Navel sports is very pronounced; the fact that Mr. Hart observed this in 1887 is interesting although his explanation of the cause was wrong.

On March 12, 1887, J. E. Cutter, a prominent citrus grower and nurseryman, of Riverside, Cal., sent in to the Department at Washington a number of samples of orange varieties. Included in the list were two distinct lots of

A NAVEL GRAPEFRUIT

This variable fruit (photographed actual size) shows two great deviations from the original condition of the grapefruit. In the first place, it has lost its seeds; in the second place it has taken on a navel, just like that of the navel orange. In the case of the grapefruit, the navel is scarcely visible from the outside. This fruit is of no particular value commercially, but serves graphically to illustrate the fact that extreme bud variations or "sports" are constantly taking place in the citrus fruits, and probably in all other cultivated fruits. It is highly necessary that horticulturists keep on the lookout for such variations, and that they propagate from the desirable, not the undesirable ones. The orange industry of California is now being almost made over, in some sections, by attention to this principle. (Fig. 6.)

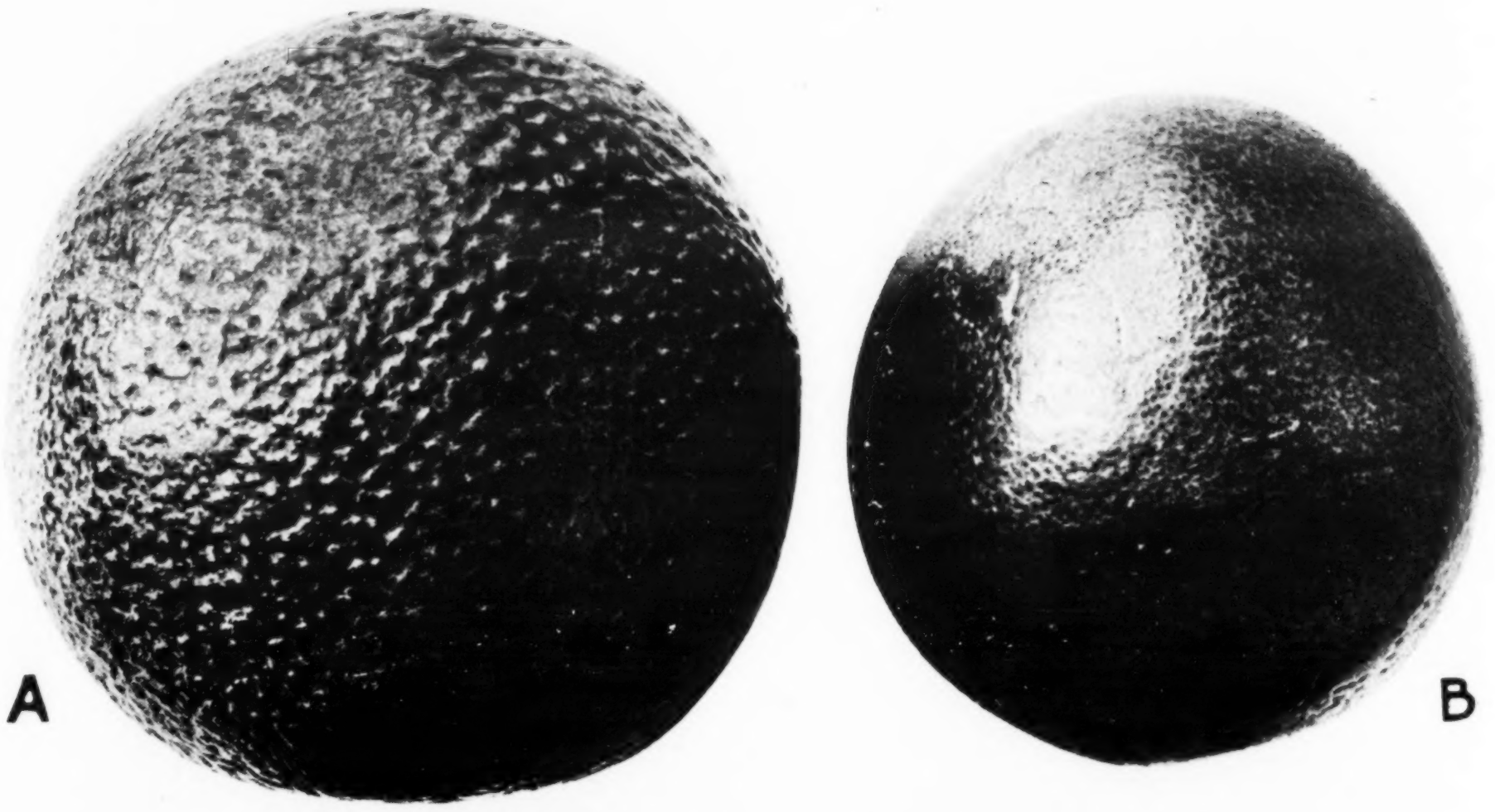
Paper Rind St. Michael fruits borne on two separate trees. One of these lots Mr. Cutter designated as the normal Paper Rind St. Michael and the other as "Reverted Types." In commenting on the "Reverted types" he said:

"The 'Reverted Types' of the St. Michael are from a tree which is bearing at the time the usual type of the same. A comparison of these 'Reverted Types' with the usual and with common oranges shows that the St. Michael, . . . so highly prized for its splendid quality, juiciness and solidity . . . is itself a sport. Specimens are occasionally found which are half 'Paper Rind' and half 'Reverted.'"

On April 21, 1887, in reply to a request for further information concerning the St. Michael variations he wrote as follows:

PAPER RIND VALENCIAS

"In my former letter I used the term 'reverted type' [of St. Michael oranges] to indicate an orange that has *sported back* to the normal form, appearance and quality. These 'reverted types' grew on the same trees and among the usual kind of 'paper rind' St. Michaels.



STRIKING VALENCIA VARIATIONS

At the left is shown the Standard Valencia orange, a California variety which has almost a monopoly of the eastern markets in the summer. At the right is a bud sport of the Valencia, to which the name of Paper Rind has been given. Evidence from orange growers of the last generation indicates that this particular bud sport has often occurred. This particular Valencia strain appears to be identical with the true Paper Rind St. Michael which originated as a bud variation of the St. Michael. Photograph slightly reduced. (Fig. 7.)

I therefore regard them as proof that the 'paper rind' St. Michael is a *sport*. You will remember that the 'reverted types' were of the thicker skin, deeper color, and looser texture of common fruit while the 'paper rind' is the thinnest of skin, pale and exceedingly compact and firm textured."

Mr. Cutter's observations as to the origin of the Paper Rind St. Michael are all the more interesting in view of the fact that in the course of the fruit improvement investigations which Mr. Shamel is conducting in California, a smooth, thin skin strain of Valencia orange has been found which apparently is identical with the Paper Rind St. Michael. The finding of this strain of Valencia, and the fact that Mr. Cutter in 1887 observed a St. Michael tree the fruits of which reverted back to a larger coarser strain would seem to be almost conclusive proof that the Paper Rind St. Michael variety originated as a bud sport or bud variation. How valuable it would be if we could secure authentic information concerning all our fruit varieties. No doubt if we could get at the truth concerning the origin of our fruit varieties we would find that many varieties of supposedly "chance seedling" origin had in reality originated as bud variations.

Mr. Cutter sent samples of the sporting fruits to a number of people in Florida and E. H. Hart, of Federal Point, Fla., previously referred to, in a letter on May 21, 1887, to Prof. H. E. Van Deman made the following comment:

"Yours of the eighteenth together with Mr. Cutter's letter and the specimens of oranges were received today. Fruits like these are occasionally seen upon our orange trees and in general I have attributed their peculiariities to cross-fertilization but in a strongly marked case like that tree of Mr. Cutter's, it must be owing either to the influences upon the condition of the tree of the injuries formerly received, or it may be an instance of bud variation. The reverting tendency may have existed in the particular bud used in working over the tree. I have an old bearing tree which has always produced

these varying types of oranges very abundantly and although I have not given much thought to the subject, yet the bud-variation theory seemed the easiest way of explaining the difficulty."

After discussing some other subjects he gives an instance of bud variation which has come under his own observation.

"The orange known here as Duroi is frequently marked with ribbed segments differing in exterior from the remainder of the affected specimen which would suggest the permanency of the reversion theory in that particular variety."

MANY VARIATIONS

Other instances of bud variations were mentioned by Mr. Hart in a letter of May 9, 1888, to Prof. Van Deman:

"I would remark here that the normal shape of Hart's Late is oblong—often to a marked degree—but growing as they do all about among other kinds, the shape is modified by admixtures. I notice the same in the case of Early Oblong, which are often so changed in form as to be hardly recognizable."

A very careful student and a recognized authority on pomological matters in Florida at this time was the Rev. Lyman Phelps, of Sanford, Fla. In a letter from him under date of May 6, 1887, to Prof. Van Deman he makes the following observations concerning bud variations:

"I send you three oranges this morning by mail, two flat ones—they are a sport of some kind from an Italian orange, not from seed but from bud. I have perhaps a hundred trees budded from a tree imported by Gen. H. S. Sanford and this particular tree has borne this shaped orange continually. It is more solid than any of the fruit on the other trees and most of the specimens show umbilical marks."

John Carville Stovin, of Winter Park, Fla., in a letter written May 20, 1887, to Prof. Van Deman, states:

"The best Italian orange grown at Belair and imported by Mr. Sanford has sported into a Navel in one tree on my place."

These few instances have been chosen from many which might be given for the reason that the observations were made by men prominently identified with the fruit industry of their day. These observations simply add their support to the rapidly accumulating mass of evidence, going to show that variations have existed within standard fruit varieties in greater numbers than anyone has dreamed were possible, and also that great care has to be used in selecting budwood in order that the chance of propagating undesirable variations may be eliminated.

Improving the Wheat of Sweden

The introduction of several new varieties of wheat is reported by H. Nilsson-Ehle in the Sveriges Utsädesförenings Tidskrift, summarized in the *International Review of Agriculture*. The latest productions of the Svalöf station are named Pansar and Fylgia; their yields are respectively 140 and 135 if the native Swedish wheat is taken at 100. The work of the Svalöf station, which offers one of the most conspicuous successes in both the theory and practice of plant-breeding, was described by its director in the JOURNAL OF HEREDITY for July, 1914 (Vol. V, No. 7).

Annual Meeting of the A. G. A.

The annual meeting of the American Genetic Association will be held in New York City, December 26–31, in connection with the American Association for the Advancement of Science. Members who wish to contribute papers to the program should communicate with the secretary as soon as possible.

HEREDITY AND THE MIND

Many Kinds of Logical Evidence that Mental Traits Are Inherited in the Same Way and to the Same Extent as Physical Characters—Educators Must Deal with This Fact, and not Be Misled by Dogmas of Speculative Psychology

THE EDITOR

IT IS the fashion nowadays, among some psychologists and educators, to attack the inheritance of mental traits. Of course, it is granted that some sort of a groundwork must be transmitted, but we are asked by the extremists to believe that this is little more than a clean slate on which the environment, particularly during the early years of life, writes its autograph.

"What is often called heredity," we are told,[1] "is merely the expression of the subconscious ego, whose origin can often be traced back to early childhood, to the time when the acts of their parents and their example left their impress in the unconscious."

"Idiosyncrasies of action, peculiarities, sympathies, likes and dislikes, prejudices, preformed judgments, aggressiveness, passivity, marked artistic ability and tendencies, temperament, these and many more traits," we are informed,[2] "have been explained on the basis of acquired complexes. And as far as the evidence and explanations are concerned, they both seem quite valid."

"Every child," we are assured,[3] "at the outset of his life is a little impulsive being, pushed indifferently toward good or evil according to the influences which surround him."

Such criticisms are a useful stimulus, but they must be given no more weight than they deserve.

If it were true that heredity can deal only with the physical, and not with the mental, then eugenics would have little excuse for existence; for its primary object is to increase the amount of ability in the race, and it depends for success on the belief that differences in ability are due to differences in heredity.

But is it true? Has genetics no valid evidence that mental traits are inherited?

PROGRESS IN ANALYSIS IS SLOW

It must be admitted that the analysis of the inheritance of mental traits is proceeding slowly. This is not the fault of the geneticist, but rather of the psychologist, who has not yet been able to furnish the geneticist with the description of definite traits of such a character as to make possible the exhaustive analysis of their individual inheritance. That department of psychology is only now being formed.

We might even admit that no inherited "unit character" in the mind has yet been isolated; but it would be a great mistake to assume from this admission that proof of the inheritance of mental qualities, in general, is lacking.

The psychologists and educators who think so appear either to be swayed by the necessity of supporting dogmatic or metaphysical views of the mind, or else they think that resemblance between parent and offspring is the only evidence of inheritance that we can offer. The father dislikes cheese; the son dislikes cheese. "Aha, you think that is the inheritance of a dislike for cheese," cries the psychologist, "but we will

[1] Waldstein, L. Das unterbewusste Ich und sein Verhaltnis zu Gesundheit und Erziehung. Grenzfr. des Nerven u. Seelenlehre, Band 9 (1908), Heft 62, p. 8. Quoted by Kohs, *infra*.

[2] Kohs, S. C. New Light on Eugenics. JOURNAL OF HEREDITY, Vol. VII (1915), p. 450.

[3] Bruce, H. Addington, in *The Century Magazine*. The phrase is borrowed from Pascal, a fact which gives an idea of Bruce's psychological orientation.

teach you better." An interesting example of this sort of teaching is furnished by Dr. Boris Sidis, lately professor of psychology at Harvard, whose feelings are outraged because geneticists have represented that some forms of insanity are hereditary. He declaims for several pages[4] in this fashion.

> "The so-called scientific method of the eugenists is radically faulty, in spite of the rich display of colored plates, stained tables, glittering biological speculations, brilliant mathematical formulae and complicated statistical calculations. The eugenists pile Ossa on Pelion of facts by the simple method of enumeration which Bacon and the thinkers coming after him have long ago condemned as puerile and futile. From the savage's belief in sympathetic, imitative magic with its consequent superstitions, omens, and taboos down to the articles of faith and dogmas of the eugenists we find the same faulty, primitive thought, guided by the puerile, imbecile method of simple enumeration, and controlled by the wisdom of the logical *post hoc, ergo propter hoc.*"

Now if resemblance between parent and offspring were, as Sidis supposes, the only evidence of inheritance of mental traits which the geneticist can produce, his case would indeed be weak. And it is perfectly true that "evidence" of this kind has sometimes been advanced by geneticists who should have known better.

But this is not the real evidence which genetics offers. The evidence is of numerous kinds, and several lines might be destroyed without impairing the validity of the remainder. It is impossible to review the whole body of evidence here, but some of the various kinds may be indicated, and samples given. The reader will then be able to form his own opinion as to whether the geneticists' proofs or the mere assurances of a few psychologists like Sidis are the more weighty.

1. The analogy from breeding experiments. Tame rats, for instance, exhibit about as much life as a bag of meal; their offspring can be handled without a bit of trouble. The wild rat, on the other hand, is always ready to fight at the drop of the hat.

Prof. W. E. Castle, of Harvard University, writes:[5] "We have repeatedly mated tame female rats with wild males, the mothers being removed to isolated cages before the birth of the young. These young which had never seen or been near their father were very wild in disposition in every case. The observations of Yerkes on such rats raised by us indicates that their wildness was not quite as extreme as that of the pure wild rat but closely approached it."

Who can suggest any plausible explanation of their conduct, save that they inherited a certain temperament from their sire? Yet the inheritance of temperament is one of the things which the psychologists most "view with alarm." If it is proved in other animals, can we accept the psychologists' declaration that it is wholly impossible in man?

EVIDENCE FROM SEGREGATION

2. The segregation of mental traits. When an insane, or epileptic, or feeble-minded person mates with a normal individual, in whose family no taint is found, the offspring (generally speaking) will all be mentally sound, even though one parent is affected. On the other hand, if two people from tainted stocks marry, although neither one may

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[4] Sidis, Boris, M.A., Ph.D., M.D. Neurosis and Eugenics. *Medical Review of Reviews*, Vol. XXI, No. 10, pp. 587–594, New York, October, 1915. Dr. Sidis' article may be good medicine for the patients of the Sidis Psychotherapeutic Institute, Portsmouth, N. H., but it is not good science. How little he knows of elementary biology is revealed by an allusion (p. 591) to "some miraculous germ-plasm (chromatin) with wonderful dominant 'units' (chromosomes)." A college freshman in biology would be ashamed to think that chromosomes and hereditary unit characters are the same thing. A distinguished psychologist who does not know the difference, and who writes of "dominant chromosomes," is hardly a competent critic of the facts of heredity.

[5] Dr. Sewall Wright called my attention to this critical evidence, and Dr. Castle furnished the details, in a letter dated August 4, 1916. He adds, "I am not satisfied that a clear statement can be made at the present time as to the inheritance in later generations. But my impression is, from handling large numbers of second generation rats, that there is little evidence of segregation and I am inclined to think that the inheritance is blending. As to the principal question which you raise whether temperament is inherited or not there is no doubt. The only question arises as to the precise manner of its inheritance."

be personally defective, part of their offspring will be affected.

This production of sound children from an unsound parent, in the first case, and unsound children from two apparently sound parents in the second case, is exactly the opposite of what we should expect if the child gets his unsoundness merely by imitation or "contagion." The difference cannot reasonably be explained by any difference in environment or external stimuli. Heredity offers a satisfactory explanation, for some forms of feeblemindedness and epilepsy, and some of the diseases known as insanity behave as recessives and segregate in just the way mentioned. We can show abundant analogies in the inheritance of other traits in man, lower animals, and plants, that behave in exactly the same manner.

So far as I am aware, no psychologist has yet come forward to "demonstrate" that feeblemindedness is due to a subconscious complex formed in childhood, instead of to heredity, but some of them appear to be moving in that direction. No one would allege that all mental defect is due to inheritance; perhaps only a small part is, although all data now available indicate that the part is a majority. But there are many cases in which the heredity factor can hardly be denied without stultification; and if mental defects are inherited, then it is worth while investigating whether mental excellences may not be.

EVIDENCE FROM TWINS

3. The persistence of like qualities regardless of difference in environment. Any parent with open eyes must see this in his own children—must see that they retained the inherited traits even when living under entirely different surroundings. But the histories of twins furnish the most graphic evidence. Galton, who collected detailed histories of thirty-five pairs of twins who were closely alike at birth, and examined their history in after years, writes,[6] "In some cases the resemblance of body and mind had continued unaltered up to old age, notwithstanding very different conditions of life," in other cases where some dissimilarity developed, it could be traced to the influence of an illness. Making due allowance for the influence of illness, yet "instances do exist of an apparently thorough similarity of nature, in which such difference of external circumstances as may be consistent with the ordinary conditions of the same social rank and country do not create dissimilarity. Positive evidence, such as this, cannot be outweighed by any amount of negative evidence."

Dr. Frederick Adams Woods has brought forward[7] a piece of more exact evidence under this head. We know by many quantitative studies that, in physical heredity, the influence of the paternal grandparents and the influence of the maternal grandparents is equal; on the average one will contribute no more to the grandchildren than the other. If mental qualities are due rather to early surroundings than to actual inheritance, this equality of grandparental influence is incredible in the royal families where Woods got his material; for the grandchild has been brought up at the court of the paternal grandfather, where he ought to have got all his "acquirements," and has perhaps never even seen his maternal grandparents, who therefore could not be expected to impress their mental peculiarities on him by "contagion." When Woods actually measured the extent of resemblance to the two sets of grandparents, for mental and moral qualities, he found it to be the same in each case: as is inevitable if they are inherited, but as is incomprehensible if heredity is not responsible for one's mental makeup.

ENVIRONMENT IS POWERLESS

4. Persistence of unlike qualities regardless of sameness in the environment. This is the converse of the preceding proposition, but even more convincing. Here again, I quote Galton,[8] with a

[6] Galton, Francis. Inquiries into Human Faculty, p. 167. London, 1907.
[7] Woods, Frederick Adams. Heredity in Royalty. New York, 1906.
[8] *Op. cit.*, pp. 170–171.

preliminary remark about the nature of twins.

There appear to be two ways in which twins are ordinarily produced. They may be the result of the simultaneous fertilization of two egg-cells, in which case they are no different from ordinary brothers, or sisters, except that they happen to be born simultaneously. On the other hand, they may be produced by a division of a single egg-cell, at an early stage in development; in such cases they are always of the same sex, and very closely alike, as one would expect from the fact that they are really halves of the same individual.

In the former quotation from Galton, we dealt with the second class, the so-called identical twins, who are very much alike at birth for the good reason that they have identical heredity. We found that this heredity was not modified, either in the body or in the mind, by ordinary differences of training and environment. A few of Galton's histories of ordinary, non-identical twins, follow:

> One parent says: "They have had *exactly the same nurture* from their birth up to the present time; they are both perfectly healthy and strong, yet they are otherwise as dissimilar as two boys could be, physically, mentally, and in their emotional nature."
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> Another writes: "I can answer most decidedly that the twins have been perfectly dissimilar in character, habits and likeness from the moment of their birth to the present time, although they were nursed by the same woman, went to school together, and were never separated until the age of 15."
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> "Very dissimilar in body and mind," is the description of another parent. "The one is quiet, retiring, and slow but sure; good tempered, but disposed to be sulky when provoked—the other is quick, vivacious, forward, acquiring easily and forgetting soon; quick-tempered and choleric but easily forgetting and forgiving. They have been educated together and never separated."
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> Again, "The two sisters are very different in ability and disposition. The one is retiring, but firm and determined; she has no taste for music or drawing. The other is of an active, excitable temperament: she displays an unusual amount of quickness and talent, and is passionately fond of music and drawing. From infancy, they have rarely been separated even at school, and as children visiting their friends, they always were together."

If, in the face of such examples, the psychologist can maintain that differences in mental make-up are due to different influences during childhood, and not to differences in heredity, he certainly has a colossal faith in his theories. We are not obliged to depend, under this head, for mere descriptions, but can supply accurate measurements to demonstrate our point. If the environment creates the mental nature, then ordinary brothers, not more than four or five years apart in age, ought to be about as closely similar to each other as identical twins are to each other; for the family influences in each case are practically the same. Thorndike, by careful mental tests, showed[9] that this is not true. The ordinary brothers come from different egg-cells, and, as we know from studies on lower animals, they do not get exactly the same inheritance from their parents; they show, therefore, considerable differences in their psychic natures. Real identical twins are two halves of the same egg-cell, they halve the same heredity, and their natures are therefore much more nearly identical.

Again, if the mind is molded during the "plastic years of childhood," children ought to become more alike, the longer they are together. Twins who were unlike at birth ought to resemble each other more closely at 14 than they did at 9, since they have been for five additional years subjected to this supposedly potent but very mystical "molding force." Here again Thorndike's exact measurements explode the fallacy. They are actually, measurably, less alike at the older age; their inborn natures are developing along predestined lines, with little regard to the identity

[9] Thorndike, E. L. Measurements of Twins. *Arch. of Philos., Psych., and Sci. Methods*, No. 1, New York, 1905; summarized in his Educational Psychology, Vol. III, pp. 247–251, New York, 1914. Measured on a scale where 1 = identity, he found that twins showed a resemblance to each other of about .75, while ordinary brothers of about the same age resembled each other to the extent of about .50 only. The resemblance was approximately the same in both physical and mental traits.

of their surroundings. Heredity accounts easily for these facts, but they cannot be squared with the idea that mental differences are the products solely of early training.

THE EFFECT OF TRAINING

5. Differential rates of increase in qualities subject to much training. If the mind is formed by training, then brothers ought to be more alike in qualities which have been subject to much training, than they are in qualities which have been subject to little or no training. Thorndike's measurements on this point show the reverse to be true. The likeness of various traits is determined by heredity, and they may be most unlike in traits which have been subjected to a large and equal amount of training. Twins were found to be less alike in their ability at addition and multiplication, in which the schools had been training them for some years, than they were in their ability to mark off the A's on a printed sheet, or to write the opposites to a list of words—feats which they had probably never before tried to do.

This same proposition may be put on a broader basis.[10] "In so far as the differences in achievement found amongst a group of men are due to the differences in the quantity and quality of training which they had had in the function in question, the provision of equal amounts of the same sort of training for all individuals in the group should act to *reduce* the differences." "If the addition of equal amounts of practice does *not* reduce the differences found amongst men, those differences cannot well be explained to any large extent by supposing them to have been due to corresponding differences in amount of previous practice. If, that is, inequalities in achievement are not reduced by equalizing practice, they cannot well have been caused by inequalities in previous practice. If differences in opportunity cause the differences men display, making opportunity more nearly equal for all by adding equal amounts to it in each case should make the differences less.

"The facts found are rather startling. Equalizing practice *seems to increase differences*. The superior man seems to have got his present superiority by his own nature rather than by superior advantages of the past, since, during a period of equal advantages for all, he increases his lead." This point has been tested by such simple devices as mental multiplication, addition, marking A's on a printed sheet of capitals and the like; all the contestants made some gain in efficiency, but those who were superior at the start were proportionately *farther ahead than ever* at the end. This is what the geneticist would expect, but fits very ill with the popular psychology which denies that any child is mentally limited by nature.

MEASURING RESEMBLANCE

6. Direct measurement of the amount of resemblance of mental traits in brothers and sisters shows that it is on the average equal to that of physical traits. It is manifestly impossible to assume that early training, or parental behavior, or anything of the sort, can have influenced very markedly the child's eye color, or the length of his forearm, or the ratio of the length of his head to its breadth. If we measure the amount of resemblance between two brothers in such traits, we may say very confidently that our measurement represents the influence of heredity; that the child inherits his eye color and other physical traits of that kind from his parents. The resemblance, measured on a scale from 0 to 1, has been found to be about 0.5.

Pearson measured the resemblance between brothers and sisters in mental traits—for example temper, conscientiousness, introspection, vivacity—and found it on the average to have just the same intensity—that is, about 0.5. Further measurements of this sort with other traits are needed; but if future investigations confirm Pearson's finding that the resemblance between brothers

[10] The quotations in this and the following paragraph are from Thorndike's Educational Psychology, pp. 304–305, Vol. III.

and sisters for mental traits is the same as it is for physical traits, then we cannot help being struck by the remarkable coincidence.

Or is it a coincidence? We have the measurement of a large number of traits; and as Pearson points out, any mathematician who calculates the chances that it is a mere coincidence, will find the odds so heavily against him that it is hardly conceivable that it is a mere coincidence. Prof. Pearson was obliged to conclude that it shows mental traits are inherited in the same way, and to the same degree as physical traits. This line of reasoning has not proved wholly acceptable to many psychologists; but none has yet been able to offer any other sensible explanation of the supposed coincidence. Prof. Pearson writes:[11]

"It has been suggested that this resemblance in the psychological characters is compounded of two factors, inheritance on the one hand and training and environment on the other. If so, you must admit that inheritance and environment make up the resemblance in the physical characters. Now these two sorts of resemblance being of the same intensity, either the environmental influence is the same in both cases or it is not. If it is the same, we are forced to the conclusion that it is insensible, for it cannot influence eye-color. If it is not the same, than it would be a most marvellous thing that with varying degrees of inheritance, some mysterious force always modifies the extent of home influence, until the resemblance of brothers and sisters is brought sensibly up to the same intensity! Occam's razor[12] will enable us at once to cut off such a theory. We are forced, I think literally forced, to the general conclusion that the physical and psychical characters in man are inherited within broad lines in the same manner, and with the same intensity. The average home environment, the average parental influence is in itself part of the heritage of the stock and not an extraneous and additional factor emphasizing the resemblance between children from the same home."

A paragraph from Schuster[13] may appropriately be added. "After considering the published evidence a word must be said of facts which most people may collect for themselves. They are difficult to record, but are perhaps more convincing than any quantity of statistics. If one knows well several members of a family, one is bound to see in them likenesses with regard to mental traits, both large and small, which may sometimes be accounted for by example on the one hand or unconscious imitation on the other, but are often quite inexplicable on any other theory than heredity. It is difficult to understand how the inheritance of mental capacity can be denied by those whose eyes are open and whose minds are open too."

Broadly speaking, it is of course true that man inherits nothing more than the capacity of making mental acquirements. But this general capacity is made up of many separate capacities, all of these capacities are variable, and the variations are inherited. Such is the unmistakable verdict of the evidence.

It follows, then, that the only sure way to increase the amount of mental ability in the race is by encouraging parents who have ability to produce offspring, and by discouraging parents who lack ability from producing offspring. In this way the level of ability—at least, potential ability—will inevitably rise with each generation.

It follows, too, that attempts made by educators to create ability by education, where the inherited capacity does not exist, are doomed to failure. On the other hand, a scientific system of education which would ascertain what innate capacities the child has, and develop them as far as was desirable would probably produce a surprisingly effective result.

Our conclusions as to the inheritance of all sorts of mental capacity are not

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[11] Biometrika, Vol. III, p. 156.

[12] "William of Occam's Razor" is the canon of logic which declares that it is foolish to seek for several causes of an effect, if a single cause is adequate to account for it.

[13] Schuster, Edgar. Eugenics, pp. 159–160. London, 1913.

based on the mere presence of the same trait in parent and child. They are based on many different kinds of proof of the most critical sort, which is often ignored but has never been controverted by the unscientific school of educators and the speculative school of psychologists.

The evidence is good as far as it goes; and one may freely admit that it does not go far enough. That it goes no farther is not the fault of the geneticist, but of the psychologist. While a small body of able men is now steadily building up a Psychology of Individual Differences, some of the most brilliant members of the profession are preferring to deal with affirmations and verbal concepts rather than with facts. If a luxuriant new hypothesis seems to make it necessary, this type of psychologist appears to feel no hesitation about covering inheritance with a cloud of dust and then asserting that the concealed object never existed. It is not surprising that some educators have been misled by this sort of procedure.

The geneticist objects to any continuation of it. The mass of exact and critical quantitative evidence for the inheritance of mental traits is still intact. Though we cannot yet isolate particular functions of the brain and show the precise mechanism by which they are inherited, we have nevertheless ample evidence to show that they *are* inherited—that, in general, the basic differences of the mind are as much due to ancestry as are differences of the body.

German Horse-Breeding and the War

The German Genetic Association has published a large volume investigating the war's effect on horse-breeding. A review of the industry prior to the war is given, then the effect of mobilization is described. Details are given of the part played by various breeds in the field and how well they have met expectations. The evil effects of war on the industry are analyzed and means suggested of overcoming them and keeping horse-breeding up to a high level: it is suggested, for example, that the best breeding stock should not be exposed to danger, and, on the other hand, that all stock which shows itself particularly valuable during the actual experience of war should be noted, and used as much as possible for breeding subsequently. The practical but all-inclusive nature of the book forms a good testimonial to the usefulness of the *Deutsche Gesellschaft für Züchtungskunde* which could prepare and publish it in the middle of the war, as it has done.

An Experiment in Sunflower Breeding

Sunflower seeds form an important source of oil in Russia and Th. Sazyperow has therefore undertaken to breed a strain which will be resistant to rust and other plant diseases. He crossed *Helianthus annuus* with *H. argophyllus* and describes the first two hybrid generations in the *Bulletin of Applied Botany*, Petrograd, May, 1916. Rust resistance is reported to be a Mendelian recessive, inherited separately from certain forms of leaf which were thought to be important in preventing the development of rust. It will be recalled that Biffen found rust resistance in wheat was also an inherited character. The discovery that disease resistance in plants is an aspect of Mendelian heredity, opens up a wide field for practical and theoretical advances in genetics. Mr. Sazyperow is continuing his researches.

MIMICRY IN BUTTERFLIES

Close Resemblances between Species May Be Protective, but Their Origin Is Difficult to Explain through Natural Selection

A Review

THE theory of mimicry in butterflies is one of the most attractive of the fascinating speculations which the early Darwinians put forward. It has long been part of the stock in trade of the text-book writer; but for a long time, too, there have been protests against the theory.

R. C. Punnett, Professor of Genetics in Cambridge University, has now collected the evidence in a beautiful book, lucidly written and illustrated with colored plates.[1] The work is a good example of the way in which many lines of biological investigation may be brought to a focus to throw light on a problem in evolution.

"Mimicry," Prof. Punnett says, "is a special branch of the study of adaptation. The term has sometimes been used loosely to include cases where an animal, most frequently an insect, bears a strong and often most remarkable resemblance to some feature of its inanimate surroundings. Many butterflies with wings closed are wonderfully like dead leaves; certain spiders when at rest on a leaf look exactly like bird-droppings; 'looper' caterpillars simulate small twigs; the names of the 'stick-' and 'leaf-' insects are in themselves an indication of their appearance. Such cases as these, in which the creature exhibits a resemblance to some part of its natural surroundings, should be classified as cases of 'protective resemblance' in contradistinction to mimicry proper. Striking examples of protective resemblance are abundant, and although we possess little critical knowledge of the acuity of perception in birds and other insect feeders it is plausible to regard such resemblances as being of definite advantage in the struggle for existence. However, it is with mimicry and not with protective resemblance in general that we are here directly concerned, and the nature of the phenomenon may perhaps best be made clear by a brief account of the facts which led to the statement of the theory.

ORIGIN OF THE THEORY

"In the middle of the last century the distinguished naturalist, H. W. Bates, was engaged in making collections in parts of the Amazon region. He paid much attention to butterflies, in which group he discovered a remarkably interesting phenomenon. Among the species which he took were a large number belonging to the group Ithomiinae, small butterflies of peculiar appearance with long slender bodies and narrow wings bearing in most cases a conspicuous pattern. When Bates came to examine his catch more closely he discovered that among the many Ithomiines were a few specimens very like them in general shape, color and markings, but differing in certain anatomical features by which the Pierinae, or 'whites,' are separated from other groups. Most Pierines are very different from Ithomiines. It is the group to which our common cabbage butterfly belongs and the ground color is generally white. The shape of the body and also of the wing is in general quite distinct from what it is in the Ithomiines. Nevertheless in these particular districts certain of the species of Pierines had departed widely from what is usually

[1] Mimicry in Butterflies, by Reginald Crundall Punnett, F.R.S., Fellow of Gonville and Caius College, Arthur Balfour Professor of Genetics in the University of Cambridge. Pp. 188, price 15 shillings. University Press, Cambridge (Eng.), 1915.

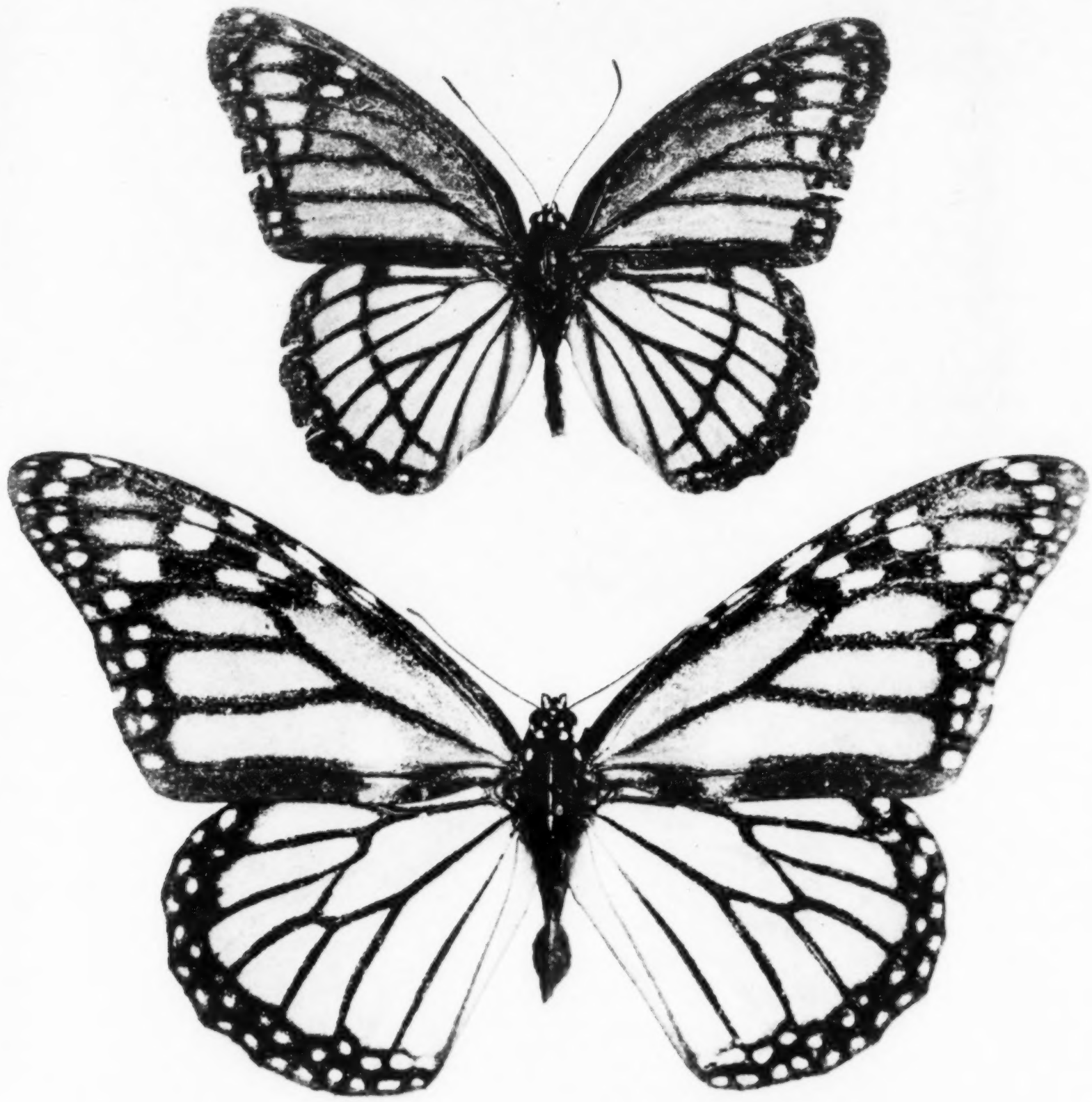
regarded as their ancestral pattern and had come to resemble very closely the far more abundant Ithomiines among whom they habitually flew. To use Bates' term they 'mimicked' the Ithomiines, and he set to work to devise an explanation of how this could have come about. The "Origin of Species" had just appeared and it was natural that Bates should seek to interpret this peculiar phenomenon on the lines there laid down. How was it that these Pierines had come to depart so widely from the general form of the great bulk of their relations, and to mimic so closely in appearance species belonging to an entirely different group, while at the same time conserving the more deep-seated anatomical features of their own family?

USEFULNESS OF CHANGE

"If the change was to be regarded as having come about through the agency of natural selection it must clearly be of advantage to the mimicking forms; otherwise natural selection could not come into operation. What advantage then have the Ithomiines over the majority of butterflies in those parts? They are small insects, rather flimsy in build, with comparatively weak powers of flight, and yet so conspicuously colored that they can hardly be mistaken for anything else. In spite of all this they are little subject to the attacks of such enemies as birds, and Bates attributed this to the fact that the juices of their bodies are unpalatable. According to him their striking and conspicuous pattern is of the nature of a warning coloration, advertising their disagreeable properties to possible enemies. A bird which had once attempted to eat one would find it little to its taste. It would thenceforward associate the conspicuous pattern with a disagreeable flavor and in future leave such butterflies severely alone. The more conspicuous the pattern the more readily would it be noticed by the enemy, and so it would be of advantage to the Ithomiine to possess as striking a pattern as possible. Those butterflies showing a tendency to a more conspicuous pattern would be more immune to the attacks of birds and so would have a better chance of leaving progeny than those with a less conspicuous pattern. In this way variations in the direction of greater conspicuousness would be accumulated gradually by natural selection, and so would be built up in the Ithomiine the striking warning coloration by which it advertises its disagreeable properties. Such is the first step in the making of a mimicry case—the building up through natural selection of a conspicuous pattern in an unpalatable species by means of which it is enabled to advertise its disagreeable properties effectively and thereby secure immunity from the attacks of enemies which are able to appreciate such advertisement. Such patterns and colors are said to be of a 'warning' nature. The existence of an unpalatable model in considerable numbers is the first step in the production of a mimetic resemblance through the agency of natural selection.

BEGINNING OF CHANGE

"We come back now to our Pierines which must be assumed to show the general characters and coloration of the family of whites to which they belong. Theoretically they are not specially protected by nauseous properties from enemies and hence their conspicuous white coloration renders them especially liable to attack. If, however, they could exchange their normal dress for one resembling that of the Ithomiines it is clear that they would have a chance of being mistaken for the latter and consequently of being left alone. Moreover, in certain cases these Pierines *have* managed to discard their normal dress and assume that of the Ithomiines. On theoretical grounds this must clearly be of advantage to them, and being so might conceivably have risen through the action of natural selection. This indeed is what is supposed to have taken place on the theory of mimicry. Those Pierines which exhibited a variation of color in the direction of the Ithomiine 'model' excited distrust in the minds of would-be devourers, who had learned from experience to associate that particular type of coloration with a dis-



A COMMON AMERICAN CASE OF MIMICRY

These two butterflies are familiar to everyone who has observed insects in the United States, and are generally regarded as offering an example of mimicry. Their coloring, a rich brown and black, is even more similar than their pattern. Below is the Monarch butterfly (*Danais archippus*) which is supposed to be unpalatable and shunned by birds after they have had one taste; above is the Viceroy (*Limenitis archippus*) belonging to a totally different family which is supposed to be edible. By mimicking the appearance of its larger and distasteful neighbor, it is supposed that the Viceroy secures protection from attacks by birds. Photographs natural size. (Fig. 8.)

agreeable taste. Such Pierines would therefore have a rather better chance of surviving and of leaving offspring. Some of the offspring would exhibit the variation in a more marked degree and these again would in consequence have a yet better chance of surviving. Natural selection would encourage those varying in the direction of the Ithomiine model at the expense of the rest and by its continuous operation there would be built up those beautiful cases of resemblance which have excited the admiration of naturalists."

Following Bates' work in South America, Alfred Russell Wallace developed the theory for the butterflies of the Indo-Malayan region, and Trimen for those of Africa. In each instance abundant cases of supposed minicry were found.

MÜLLER'S CONTRIBUTION

"We may now turn to one of the most ingenious developments of the theory of mimicry. Not long after Bates' original memoir appeared attention was directed to a group of cases which could not be explained on the simple hypothesis there put forward. Many striking cases of resemblance had been adduced in which both species obviously belonged to the presumably unpalatable groups. Instances of the sort had been recorded by Bates himself and are perhaps most plentiful in South America between species belonging respectively to the Ithomiinae and Heliconinae. On the theory of mimicry all the members of both of these groups must be regarded as specially protected owing to their conspicuous coloration and distasteful properties. What advantage, then, can an Ithomiine be supposed to gain by mimicking a Heliconine, or vice versa? Why should a species exchange its own bright and conspicuous warning pattern for one which is neither brighter nor more conspicuous? To Fritz Müller, the well-known correspondent of Darwin, belongs the credit of having suggested a way out of the difficulty.

"Müller's explanation turns upon the education of birds. Every year there hatch into the world fresh generations of young birds, and each generation has to learn afresh from experience what is pleasant to eat and what is not. They will try all things and hold fast to that which is good. They will learn to associate the gay colors of the Heliconine and the Ithomiine with an evil taste[2] and they will thenceforth avoid butterflies which advertise themselves by means of these particular color combinations. But in a locality where there are many models, each with a different pattern and color complex, each will have to be tested separately before the unpalatableness of each is realized. If, for example, a thousand young birds started their education on a population of butterflies in which there were five disagreeable species, each with a distinct warning pattern, it is clear that 1,000 of each would devote their lives to the education of these birds, or 5,000 butterflies in all. But if these five species, instead of showing five distinct warning patterns, all displayed the same one, it is evident that the education of the birds would be accomplished at the price of but 1,000 butterfly existences instead of five. Even if one of the five species were far more abundant than the others, it would yet be to its advantage that the other four should exhibit the same warning pattern. Even though the losses were distributed *pro rata* the more abundant species would profit to some extent. For the less abundant species the gain would, of course, be relatively greater. Theoretically, therefore, all of the five species would profit if in place of five distinct warning patterns they exhibited but a single one in common. And since it is profitable to all concerned, what more natural than that it should be brought about by natural selection?"

TWO TYPES OF MIMICRY

There are thus two generally accepted types of mimicry—the Batesian, where one species adopts the coloration of another, and the Müllerian, where a number of species adopt a common pattern. As to the facts, there is no room for dispute, but there is much room for dispute about the explanation of the facts.

Wallace pointed out that there are five necessary conditions which must and do exist in any case of mimicry:

1. That the imitative species occur in the same area and occupy the very same station as the imitated.

[2] "In attributing this quality to the butterflies in question I am merely stating what is held by the supporters of the mimicry theory. I know of scarcely any evidence either for or against the supposition."

2. That the imitators are always the more defenseless.

3. That the imitators are always less numerous in individuals.

4. That the imitators differ from the bulk of their allies.

5. That the imitation, however minute, is *external* and *visible* only, never extending to internal characters or to such as do not effect the external appearance.

It is true, Prof. Punnett says, that these conditions often hold good, but there are few if any cases where they all hold good. When the problem is further examined, still more difficulties are found. For instance, the butterfly is frequently captured by birds on the wing; but though two species may resemble each other closely in coloration their manner of flight is sometimes so different that it is hard to believe a bird would not see the difference between them.

Breeding experiments offer a further objection, Prof. Punnett thinks, to the idea that the mimetic pattern has been built up by natural selection from a long series of small changes. For the patterns are found to be inherited as Mendelian units and therefore, he thinks, must have appeared by one large step instead of a number of small steps: otherwise we should recover some of the intermediate steps by cross-breeding. It is not certain, however, that this argument deserves as much weight as Punnett ascribes to it.

DO BIRDS DISCRIMINATE?

Distinctly more convincing is the experimental evidence on the preferences of birds. For when they are given a chance to select between a mimic and a model, they sometimes choose the supposedly unpalatable one and reject the one which resembles it, but is, by hypothesis, comestible. If enough evidence of this sort could be accumulated, it would obviously strike at the very foundations of the mimicry hypothesis.

"It is safe to say," Punnett thinks, "that a number of species of birds have been known to attack butterflies—that a few out of the number feed upon butterflies systematically—that some of the most persistent bird enemies devour the presumably protected forms as freely as the unprotected—but that in a few instances there is some reason for supposing that the bird discriminates. Beyond this it is unsafe to go at present."

Monkeys eat butterflies readily, and appear to be more discriminating than birds. It is not impossible that they are really responsible for the establishment of some species of mimicry; for Punnett shows by mathematical calculations that even a small percentage handicap of one species is sufficient to alter its relative numbers greatly in a comparatively small number of generations. In 1850, for instance, the peppered moth *Amphidasys betularia* was common in England; at present it has been practically supplanted by a darker form, *A. doubledayaria*. The cause of this change is obscure; it is suggested that the darker form may be hardier.

The rôle of natural selection in mimicry is still further limited by a consideration of what must happen in the early stages. If a white butterfly is to assume the protective coloration of a dark form, it appears that a small spot of dark color (which, according to the selectionists, would be the start of the change) would give no real protection. Prof. Punnett declares, "Till the mimic can be mistaken for the model, natural selection plays no part. . . . The part now often attributed to natural selection is to put a polish on the resemblance and to keep it up to the mark by weeding out those which do not reach the required standard."

From these facts, and others which have not been mentioned in this review, the author holds "that there are difficulties in the way of accepting the mimicry theory as an explanation of the remarkable resemblances which are often found between butterflies belonging to distinct groups. Of these difficulties two stand out beyond the rest, viz., the difficulty of finding the agent that shall exercise the appropriate powers of discrimination, and the difficulty of fitting in the theoretical process involving the incessant accumulation of minute variations with what is at

present known of the facts of heredity."

"Looked at critically in the light of what we now know about heredity and variation, the mimicry hypothesis is an unsatisfactory explanation of the way in which these remarkable resemblances between different species of butterflies have been brought about."

PUNNETT'S EXPLANATION

Punnett's own explanation tends to bring mimicry into the field of mutation and Mendelian heredity. He suggests that the number of different inherited factors for pattern and color, in butterflies, is quite limited, so that the same assortment may not infrequently be brought together even though the group whose members exhibited the resemblance might, owing to structural differences, be placed in different families. In support of this he cites the analogy of the rodents, where the number of different hereditary factors for coat color is small, and the same colors may be found in the rabbit, the mouse and the guinea-pig.

"On this view the various color patterns found among butterflies depend primarily upon definite hereditary factors the number of which is by no means enormous. Many of these factors are common to several or many different groups, and a similar aggregate of color factors, whether in an Ithomiine, a Pierid, or a Papilio, results in a similar color scheme." When a case of mimicry is thus established, practically by accident, natural selection may perhaps preserve it; but natural selection in this view can receive no credit for creating the mimicry, as the older naturalists thought. This explanation is of course largely hypothetical, and Punnett does not pretend that the evidence is sufficient to prove it.

One can hardly deny, however, that he has made out a strong case against the omnipotent adequacy of natural selection to explain mimicry in butterflies. And the book is significant as an expression of the widespread modern objection to the *allmacht*, the all-sufficiency of natural selection as a factor in evolution, which marked the preceding generation and which still characterizes many popular writers and even a large number of biologists who are working in other fields and not in touch with the developments of genetics.

It was once thought that, if an adaptation appeared to be useful to the individual, natural selection could be invoked to account for its origin. Most geneticists now want to be shown. It is clear to them that natural selection might preserve a case of mimicry, but it is not clear to them that it could build up a case of mimicry, starting with merely trivial variations.

Natural selection as a factor in evolution is probably more firmly established today than ever before. But its place is also more sharply defined than ever before, and it is no longer universally admitted to be responsible for creating adaptations. Many biologists reached this standpoint years ago, and the attacks being made on one stronghold after another of the extreme selectionists have been successful. The attack on the natural selection explanation of mimicry in butterflies is only one of a long series which has resulted in giving a much clearer understanding of what natural selection can do and what it cannot do. For this reason, as well as for its own interest, Prof. Punnett's book deserves wide consideration.

Research in Inebriety

A research foundation has been organized at Hartford, Conn., under the directorship of Dr. T. D. Crothers, the object of which is to make a scientific study of alcoholism and inebriety. The foundation is to be endowed and will become a permanent institution. Appeals are to be made to physicians all over the country to furnish records and histories of cases in order that they may be classified and studied for the purpose of determining the laws that govern inebriety outside of the direct effects of alcohol. The institution will serve a practical end as well as becoming a center for research.—*Eugenical News.*

THE JUKES IN 1915

Huge and Notorious Clan Brought to Light by Dugdale Is Now in Its Ninth Generation—Members Have Moved to Good Environments but in Many Cases No Improvement in Their Character Is Visible—In Other Cases, by Eugenic Marriages, They Have Taken Places in Respectable Society

A REVIEW[1]

IN 1874, Richard L. Dugdale, a New York merchant[2] who was interested in prison reform, made a tour of the counties to study jail conditions. In one mountain county he found six blood relatives in prison for various offenses, and undertook a study of their heredity. The result was the publication, in 1877, of his study of the story[3] of their clan, to which he gave the fictitious name of "Juke." Ever since then, it has been regarded as the example *par excellence* of bad breeding. Its origin was commonplace enough.

"Into an isolated region, now within 2 hours' railroad journey of the nation's metropolis, there drifted nearly a century and a half ago a number of persons whose constitutions did not fit them for participation in a highly organized society. This region was the frontier of that day and those who went there had many of the characteristics of our western frontiersmen of a century later. Some of them were hunters, some were extreme nomads (tramps), and like practically all extreme nomads were addicted to drink; some were miners and found at this place opportunity to make a living at an occupation that requires no capital and which may be readily abandoned or resumed; some were neurasthenic, found muscular activity and persistence in work irksome, and craved stimulants to lighten the labor of even minimum activities; some were feebleminded, and had found that Nature makes fewer demands on intelligence than does organized society; and still more were feebly inhibited and had either already so violently offended the *mores*, as to flee the 'revenge' of society, or had found that there was less tendency to repression of their intermittent, instinctive outbreaks where the arm of organized society was not yet long enough to reach. For all of such socially inadequate this retired, well-wooded and well-watered valley afforded a haven of refuge at a day when the system of state 'institutions' had been little developed.

"That there should be such strains in a colony that had been founded only three or four generations before is not strange when we recall that the emigration of criminals and ne'er-do-wells, among others, to this new country was assisted, in order to relieve the congested centers of Europe, of some of those whose presence was incompatible with the development of high civic ideals. It is the descendants of such people, among others, that came to the region which the Juke family made notorious.

THE EARLY JUKES

"Here are some of the migrants or their immediate progeny: Max, the hunter and fisher, the jolly, alcoholic, ne'er-do-well; Lem, the stealer of sheep; Lawrence, the licentious, free with his 'gun.' Here, too, were found Margaret and Delia, the wantons, and Bell, who

[1] The Jukes in 1915. By Arthur H. Estabrook of the Eugenics Record Office. Pp. 85. Published by the Carnegie Institution of Washington, September, 1916.

[2] Dugdale was born in Paris, of English parents, in 1841. In 1851 the family came to New York City. Dugdale acquired a competence in commercial life and then devoted himself to philanthropy. He died in 1883.

[3] The Jukes: A Study in Crime, Pauperism, Disease and Heredity. By R. L. Dugdale. New York and London, G. P. Putnam's Sons, 1877. The book has gone through four editions.

had three children by various negroes. So some negro and, doubtless, some Indian blood became in time disseminated through the whole population of the valley.

"The progeny of such stock showed the expected reactions to their primitive environment. Some proved themselves feebleminded, grew up ineducable, slovenly, and inefficient, ending their lives in the poorhouse. Some became vagrants, wandering hither and thither and sometimes disappearing from view altogether. Great numbers craved drink and regarded it as the greatest good and were unable to control in any degree their use of it as long as they had money or could be trusted for it. Great numbers saw no need of regulating and, indeed, many were unable to regulate their reactions to sex impulses; so that they lived lives of grossest promiscuity in sex relations. Some showed an ugly and quarrelsome disposition. Others, like Ann Eliza, became delusional and homicidal. Indeed, assault and battery, murder, and rape are rather common, especially among the illegitimate children of Ada.

"Not only was much of the original stock bad, but improvement which might otherwise have occurred was prevented by constant inbreeding. The nervous weaknesses, the mental insufficiencies were thus brought together from *both* sides and mentally and morally defective offspring were rendered more certain. Some outbreeding there was and where it was with better stock, the progeny had better intelligence and emotional control and lines were founded that were able to hold a good position in organized society.

"Such were the Jukes a generation or two ago, when Dugdale studied them."[4] In 1911 his original manuscript was found, giving the real names and localities of the members of the clan, and with this as a clue the Eugenics Record Office wisely started to bring the study up to date, through the agency of Arthur H. Estabrook, who had already made a somewhat similar study of the "Nam" family, another great group of cacogenics.

FAMILY NOW SCATTERED

The Jukes in Dugdale's time had lived largely on the industry of cement mining in their county; shortly afterward this was abandoned, with the introduction of Portland cement, and eventually almost the entire clan had to emigrate. Estabrook found it scattered over fourteen States, and personally visited every member whom he was able to trace. Dugdale had described 709 individuals; Estabrook brought the number to 2,820, of whom 2,094 are of Juke blood; the others represent people who have married into that family.

In their original habitat the Jukes naturally had a bad environment—which they themselves had created. They likewise had a "bad name" and were of such evil repute that they were handicapped in business and social relations. When they left the valley, they went to places where their name was unknown and carried no stigma, where they had a fresh start and no handicaps. The Eugenics Record Office sought to determine what influence forty years of these varied environments had had on the old stock. Did they become useful citizens when they had a fair chance and a square deal, or did they make a new but equally bad environment wherever they went?

Estabrook's book consists mainly of a detailed description of these people, including those found by Dugdale as well as those now living. It is accompanied by extensive genealogical charts. Dr. Davenport summarizes their record as follows:

"First, on the whole, the later descendants of the Jukes, in Connecticut, in New Jersey, even in Minnesota, still show the same feeblemindedness, indolence, licentiousness and dishonesty, even when not handicapped by the associations of their bad family name and despite the fact of being surrounded by better social conditions. This is because, wherever they go, they tend

[4] The preceding paragraphs are from a preface which C. B. Davenport contributed to the work under review.

A HOME OF THE JUKES

This two-room log cabin is occupied at the present time by a member of the Juke family. Some members of the great clan are useful members of society, but entirely too many of them, living in such places as this, are a burden whom society would be much better off without. It is not sufficient to move them into a better environment, for investigation shows that to a large extent they create their own environment—a bad one—wherever they go. Photograph from Arthur H. Estabrook. (Fig. 9.)

to marry persons like themselves. On the other hand, the dispersion has led some of these descendants to marry into better stocks and this is improving the quality of the germ-plasm. To be sure, this better germ-plasm into which the Jukes marry will sometimes become contaminated with the determiners for mental weakness and lack of control; but children who show such defects are more apt to be placed under restraint in their matings when they belong to families of fair social standing than when they arise in cacogenic communities. It is probable that, in the long run, the cheapest way to improve a bad germ-plasm is to scatter it. I do not, however, recommend this course as superior to segregation; but only as a cheap and somewhat hazardous substitute. In the case of the Jukes there are so many *dominant* traits of feeble inhibition that scattering them is like scattering firebrands—each tends to start a fire in a new place. One may doubt the wisdom of the operation of 'Children's Aid Societies' which send much bad germplasm to good farming communities throughout our Middle West. It will probably have, on the whole, the same sad effects that the transportation of convicts from London to Virginia and later to Australia have had on parts of those countries.

GOOD HEREDITY ESSENTIAL

"The most important conclusion that may be drawn from Dr. Estabrook's prolonged study of the Jukes forty years later is that not merely institutional care, nor better community enviroment, will cause good social reactions in persons who are feebleminded and feebly inhibited, although, on the other hand, better stimuli will secure better reactions from weak stock than will poor stimuli. There is, indeed, no conflict between environment and heredity; each is a factor in all behavior. Environment affords the stimulus; heredity determines largely the nature of the reacting substance;

the reaction, or behavior, is the resultant or product of the two. The great mistake that social agencies have made in the past is that they have overlooked the constitutional or hereditary factor of the reaction. The chief value of a detailed study of this sort lies in this: that it demonstrates again the importance of the factor of heredity."

A more detailed examination gives little encouragement to those social optimists who think that Nature cures such plagues as the Jukes by bringing them gradually to extinction. With the increase of charity, of baby-saving devices, and misguided philanthropy, bad breeding tends rather to increase. The average fecundity of the Juke women is stated to be 3.526 children or, if those who have no children are excluded, 4.025 per female. From 20 to 30% of the births have been illegitimate.

Of the 2,094 Jukes enumerated, 1,258 are now living in this country. "Although many are old, the great majority are now in the prime of life and reproducing continually. The younger[5] generation is still in school.

"The Jukes of today are to be found in all classes of society. The good citizen, prosperous and rearing a family with good moral and mental stamina, has earned his place in the community. Then there is the more numerous class, composed of steady, hard-working persons who toil from day to day at semi-skilled or unskilled labor and make no deep impression on the community, but rear their children as well as their limited outlook on the world will allow, endeavoring at least to raise them to the parental social level. Again, there is the scum of society represented among the Jukes. These are inefficient and indolent, unwilling or unable to take advantage of any opportunity which offers itself or is offered to them. These form the real social problem of the Jukes today.

SOME USEFUL JUKES

"An attempt has been made to classify the living Jukes into these three classes. There are 748 Jukes over the age of 15 considered in this connection. There are, roughly speaking, seventy-six in the first class, the socially adequate; 255 individuals are doing fairly well; 323 are typical Jukes of the kind described by Dugdale, and ninety-four were unclassified, due to lack of sufficient information. The writer realizes that these figures mean little except to give a comparative idea of the general proportion of the three classes. As time goes on many of the younger ones classed as 'doing poorly' may, through added responsibility and as the result of experience, enter the second or even the first class. Those who remain, not profiting by experience, are the mentally deficient, for whom nothing can be done except to give continual oversight or custodial care."

Consanguineous marriage in the group is studied with care and the inference drawn "that cousin marriage in the lines where there is mental defect tends to reproduce that defect and intensify it; but when there is mental and moral strength in certain characters on both sides there may, in certain matings, arise offspring who are superior to either parent." The inheritance of eroticism and pauperism are similarly studied, but the results are hardly conclusive, in view of the difficulty of defining such traits and of separating out the environmental influences. Criminality is believed to be largely feeble-mindedness.

It was not to be expected that this study would throw much light on the heredity of specific traits, for it was not undertaken with that view, but with a view to determine the effect of a changed environment. Estabrook divides his treatment of the latter subject into "involuntary removals" and "voluntary removals." In describing the latter, he seems to overlook the fact that those who migrate voluntarily are likely to be superior to the average, or they would not have sufficient enterprise to migrate. A fairer test of environmental influence is involuntary

[5] This evidently refers to the eighth generation. The ninth generation so far includes only two individuals.

removal, under which head he lists 118 individuals who, before the age of 21, were placed in some institution (excluding jail and prison). Even here, however, it may be doubted whether the environment of a poorhouse is a particularly elevating one, most of all when the individual is grown up before being taken there. The number of children of known parentage who were placed in a really good environment while very young is not great enough to warrant any conclusions. Dr. Estabrook's conclusions should be taken with reserves:

"The institution, then, does not permanently improve the condition of some. These react afterwards in society as their sibs do who have not been in institutions. These have not inherited and so do not possess the potential traits which others can work upon and train. On the other hand, as has been stated above, many are helped and improved by institutional care and training. These individuals have a better inheritance and set of traits to develop and their better response to the new environment is due to the possession of those traits which can be molded and shaped by proper contact with others, so that in society they become good citizens."

The inferences are reasonable, but not adequately proved by the present evidence.

PUNISHMENT A FAILURE

Another 118 Jukes have been in penal institutions, and as the investigator remarks, "penal servitude as a cure for crime in the Juke family seems to have been a failure, as a feeble-minded person cannot be made normal through any sort of punishment."

Under the head of "eugenic matings" we are told that "a rough classification of the 399 fertile marriages among the Jukes gives 176 eugenic matings and 223 cacogenic matings. In the opinion of the writer, who has studied the people and their offspring, 55% of the matings are detrimental to the forward progress of the Juke family, while 45% may be considered eugenic or beneficial. The standard of a eugenic mating has been put low, as it is desired to give everyone the benefit of the effect of environment. Had these cacogenic matings been forbidden or if offspring had been prevented by sterilization, it is safe to say that in the next generation less than 5% of the whole offspring would have shown undesirable traits. As it is now, with unrestricted reproduction, over half the offspring either is mentally defective or has anti-social traits." It is to be supposed that Dr. Estabrook made these statements after careful study, but to the superficial study of the reviewer they seem too sanguine, in view of the large number of anti-social traits that are recessive. The so-called eugenic matings may be of immediate benefit to the Juke family, but it is to be feared that in the long run many of them will be highly detrimental to the nation at large.

Finally, as to the bill which the law-abiding citizens of the State must pay: Dugdale estimated a loss to society by the Juke family from 1800 to 1875 of $1,250,000, not including the drink bill. In the ensuing forty years Estabrook thinks the bill has grown to $2,093,685. "If the drink bill is added, this total becomes $2,516,685. It is estimated that $648,000 of pension money has been paid to the Jukes. Much, if not most, of this has been spent for whisky and the rest has furnished support which in most cases would otherwise have been furnished by pauper relief."

To counterbalance this, there are the earnings of the few Jukes who have been really productive. Three individuals are particularly mentioned, whose total earnings are believed to be $160,000; others have been self-supporting but little more. On the whole, there is very little offset to the bill. In a more eugenic age, such a clan as the Jukes will be looked on by Society as an unnecessary luxury.

Finally, Estabrook's general summary will be given in full, although the reviewer thinks some of the statements need qualification:

"The primary aim of this work is to present the facts of the lives of the

Jukes. For the past 130 years they have increased from five sisters to a family which numbers 2,094 people, of whom 1,258 were living in 1915. One-half of the Jukes were and are feebleminded, mentally incapable of responding normally to the expectations of society, brought up under faulty environmental conditions which they consider normal, satisfied with the fulfilment of natural passions and desires, and with no ambition or ideals in life. The other half, perhaps normal mentally and emotionally, has become socially adequate or inadequate, depending on the chance of the individual reaching or failing to reach an environment which would mold and stimulate his inherited social traits.

"There have been cited just previous to this certain cases of good citizens among the Jukes. In these men and women the bad traits which have held down their brothers and sisters have become lost and they are the fountain heads of new families of socially good strain. Heredity, whether good or bad, has its complemental factor in environment. The two determine the behavior of the individual. The social reformer and the student of eugenics must see that, no matter what the degree of perfection to which we raise the standard of the environment, the response of the individual will still depend on its constitution and the constitution must be adequate before we can attain the perfect individual, socially and eugenically.

"This study demonstrates the following:

"1. Cousin-matings in defective germplasms are undesirable, since they produce defective offspring irrespective of the parents' somatic make-up.

"2. There is an hereditary factor in licentiousness, but there are those among the Jukes who are capable of meeting the requirements of the *mores* in sex matters if only great social pressure is brought to bear on them.

"3. Pauperism is an indication of weakness, physical or mental.

"4. All of the Juke criminals were feebleminded, and the eradication of crime in defective stocks depends upon the elimination of mental deficiency.

"5. Removal of Jukes from their original habitat to new regions is beneficial to the stock *itself*, as better social pressure is brought to bear on them and there is a chance of mating into better families.

"6. One in four of the Jukes is improved socially by care in Children's Institutions.

"7. Penal institutions have little beneficial influence upon persons of defective mentality.

THE REMEDY

"The natural question which arises in the reader's mind is, 'What can be done to prevent the breeding of these defectives?' Two practical solutions of this problem are apparent. One of these is the permanent custodial care of the feebleminded men and all feebleminded women of childbearing age. The other is the sterilization of those whose germ-plasm contains the defects which society wishes to eliminate.

"The first is practicable, since there are now many custodial institutions for the feebleminded and epileptic and in some of these the patients are partly self-supporting. These institutions should be increased in number and capacity to receive all the defectives now at large and who must be cared for if the program of segregation is to be fully carried out. Out of approximately 600 living feebleminded and epileptic Jukes, there are now only three in custodial care. It is estimated that at the end of fifty years the defective germ-plasm would be practically eliminated by the segregation of all of the 600.

"Sterilization of those carrying epilepsy, feeblemindedness, etc., is entirely practicable.[6] Public sentiment, however, does not favor such a practice. Contrary to public belief, sterilization would interfere with the real liberty of the individual less than custodial care."

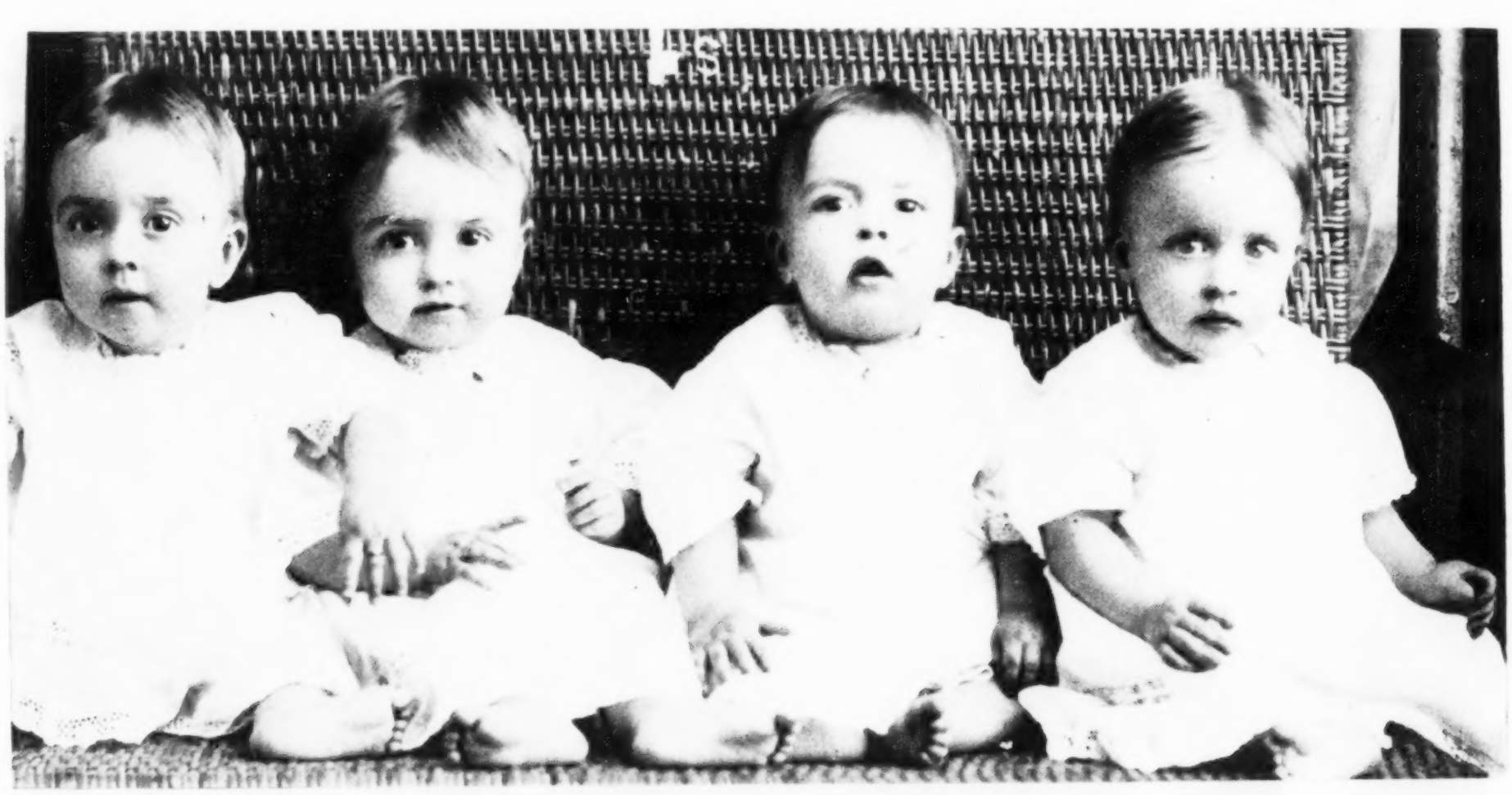
[6] Dr. Estabrook and Dr. Davenport have both emphasized the extreme sexual license of the Jukes, and their infection with venereal disease. These facts seem to the reviewer to make sterilization unthinkable. Life-long segregation for both men and women is the only remedy which will adequately safeguard both society and the individual Jukes.

WOMEN'S EYES AND POTATO SKINS

WHEN a photograph of the Keys quadruplets was published in the May issue of this Journal, a number of members commented on the eye color of the girls. It had been suggested that the four children probably represented the "identical" type of plural births; that is, the case where a single fertilized egg-cell splits up, at the beginning of development, and a complete individual is produced by each separate half, or quarter as the case may be. Ordinary twins are produced by the fertilization of two separate egg-cells, and they are therefore not expected to be any more alike than ordinary brothers and sisters. But identical twins or quadruplets, being in reality only one individual divided up, are expected to show the astoundingly close similarity which is occasionally found in life as well as in literature.

If the Keys quadruplets are of this identical type, it was asked, how can it be that three of them have brown eyes, while the eyes of the fourth are very clearly blue? The difference is easily seen in Fig. 10, and is confirmed by a letter from the father, who writes that three have brown hair and eyes, while Leota is a "a perfect blonde."

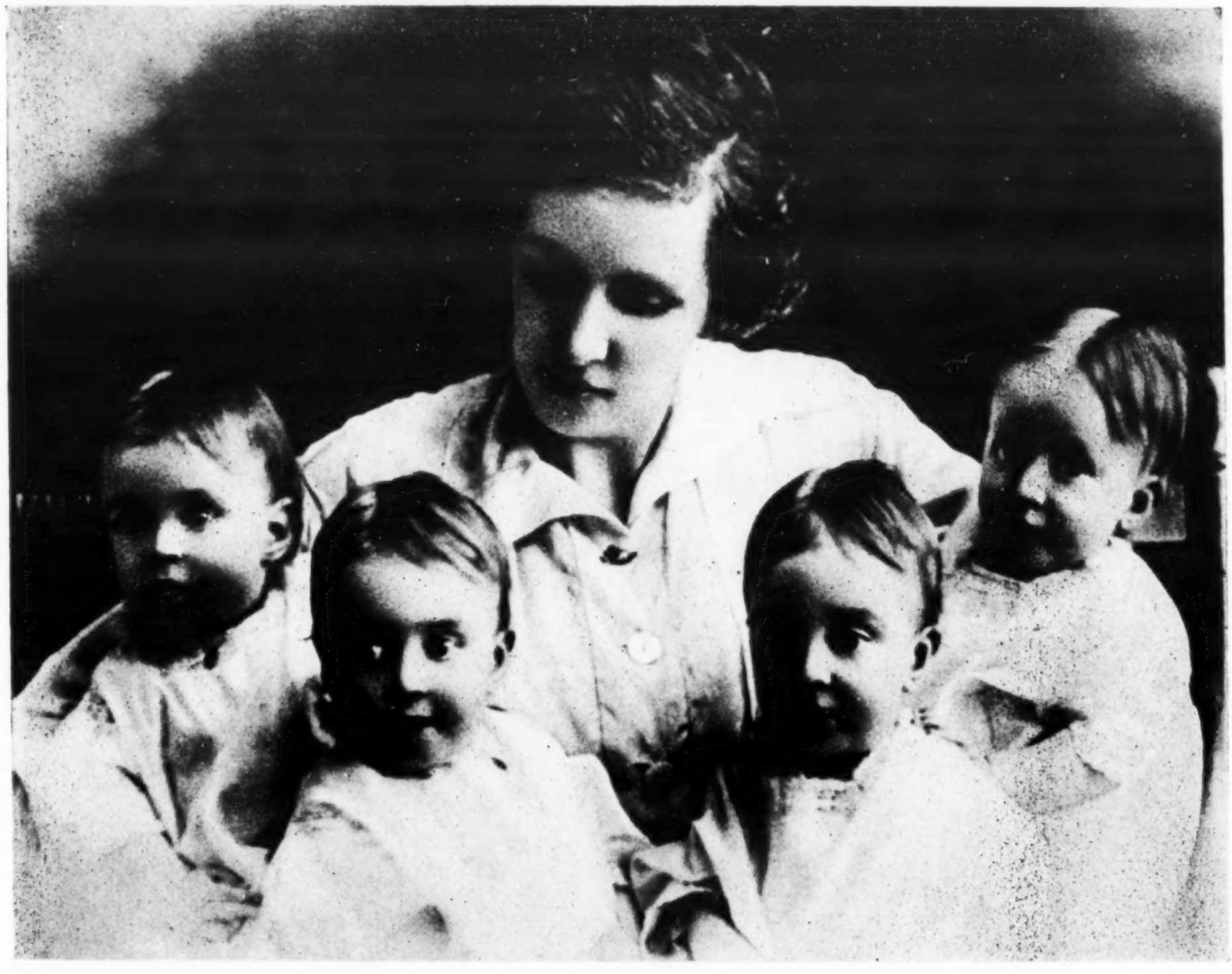
Now we have no proof that these quadruplets are "identical," in the genetic sense. The fact that they are all of one sex, and show a considerable resemblance, causes one to think that they may be. The fact that Leota has blue eyes is not necessarily evidence that they are not merely four quarters of one original egg. Prof. R. Ruggles Gates of the University of California has pointed out, in a letter to this Journal, that the discrepancy might be explained in the way that E. M. East



ROBERTA MONA MARY LEOTA

THE KEYS QUADRUPLETS ON THEIR FIRST BIRTHDAY

Leota has the distinction of blue eyes, while the three others have brown. It is suggested that, like her sisters, she may have inherited the brown pigment, but that she lost it at some time while the eyes were developing. Such a loss of an inherited factor is often seen in plants. Photograph copyrighted by F. M. Keys. (Fig. 10.)



THE QUADRUPLETS AND THEIR MOTHER

Mrs. Keys is 35 years old and weighs about 150 pounds. She has borne four children previously. The quadruplets, until they were nine months old, had no other food than mother's milk. This photograph, showing them at the age of one year (arranged in the same order as in Fig. 10) is copyrighted by F. M. Keys. (Fig. 11.)

has explained the occurrence of potatoes with white skins.[1]

The tuber of the wild potato has a purple skin, but in cultivation nowadays we find two types, one with a purple skin and the other with a white skin. The latter corresponds to albino forms of other plants; it is light colored merely because the agent that normally produces pigment is not present.

East found, as a result of inquiries and of his own breeding experiments, that colored skin and white skin formed a contrasted pair of Mendelian characters. Color was dominant, and the white skin could appear only if color was lacking. If a colored potato and a white potato were crossed, the offspring were all colored; on the other hand when a white-skinned variety was propagated asexually, by its tubers, it remained white generation after generation.

But when a purple-skinned variety was propagated by tubers, it did not invariably remain purple, generation after generation. All of a sudden, the purple might disappear, and one or more plants would be turned up with white-skinned tubers.

Propagation being asexual, this loss of color could not be due to hybridization. It is the kind of a change which goes under the name of bud-variation, and East decided that it represented the dropping out of the character "color" at some time when the vegetative cells of the potato were dividing, during its period of growth.

Study of similar bud variations in other plants convinced him that the same thing was occurring there.

[1] Annual report of the Connecticut Agricultural Experiment Station, 1909-10, pp. 134–140.

Seventy-five per cent of the cases, he thought, could be explained by the hypothesis[2] that "There has been simply the *loss* of a *dominant* character and hence the appearance of a *related recessive* character."

This hypothesis has been accepted by most geneticists as a good explanation of the sudden change of potato skins from purple to white. And as Dr. Gates has pointed out, it can also explain the sudden change of a girl's eyes from brown to blue; for brown and blue, in the human eye, appear to be related to each other in the same way that purple and white are in potato skins; the darker color is dominant and the lighter one recessive.[3]

Now a field of potato plants, propagated by tubers ("eyes") really represents just so many parts of a single individual. Similarly we may assume that these quadruplets represent just so many parts of a single individual. It is not asserted that this is the case, for we have no real proof. We make the assumption for the sake of illustration. If the assumption is correct, then the blue in Leota's eyes appeared because the brown dropped out, just as in one potato the white may appear because the purple drops out. The parallel is a homely one, but it strikingly illustrates the fact that heredity in man follows the same laws as heredity in the lower animals, and in plants. It is introduced here merely to point out that individuals are not necessarily all alike, even if they have identical heredity, as identical twins have and as potatoes or other plants propagated asexually have. There is always the possibility of "somatic segregation," which produces white-skinned potatoes and might be responsible for Leota's azure orbs.

Emigration after the War

Eugenicists have called attention to the problems which may be presented by immigration from Europe after the war, but an editorial in the New York *Times* suggests another problem which has not been foreseen. Steamship passenger agents are quoted as saying that there will be a great exodus from the United States when peace is declared, many aliens going home to help rebuild their native countries. It is estimated that a million may go back, and that half of these will stay back. As evidence of the truth of this view, they point to reservations already made for passage, by citizens of warring nations.

Those who are patriotic enough to go home and take part in a period of reconstruction are likely to be a superior lot of people, and from a eugenic viewpoint the United States can ill afford permanently to lose half a million such residents, particularly if their places are filled by undesirable immigrants who may have been unsettled by army life until they are unwilling to go back to their old occupations.

The *Times* concludes: "Those who look for a great many immigrants say that some will come to avoid heavy taxes, some because they are unwilling to return to European mines and mills from the armies in which they have served, and others—a host of widows and orphans—to be helped by relatives and friends here. But it is admitted that several European nations will probably prohibit emigration, and that Great Britain plans to find land for her disbanded soldiers in Australia, New Zealand, and South Africa. Predictions that a great number will come to this country are based upon arguments and reasoning that may be sound, but in the deposits of passage money the steamship agents have solid facts."

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[2] Plant World, XI (1908), pp. 77–83.

[3] The father of the quadruplets writes that his wife has blue eyes, as have all her "folks." She is, then, homozygous for blue, and the brown must have come through her husband. He states that he and his eleven brothers and sisters all have dark eyes, that they "take after my mother." "My mother's people all have dark hair and eyes," he continues; "my father has blue eyes as most of his family have." The ancestry of the quadruplets is therefore full of blue eyes, and it is certain not only that there is blue in Leota's eyes, as is easily seen, but that there is also blue in the eyes of her three sisters, although it cannot be seen because it is overlaid with the dominant brown.

ARE MORE BOYS BORN IN WAR TIME?

IT IS acknowledged that the present war will leave a great dearth of males in Europe, but it is sometimes alleged that Nature provides a compensated sex-ratio in births during and after such periods. Readers of Westermarck's "History of Human Marriage" will remember that, in Chapter XXI, he quotes many supposed authorities to show that more boys than usual are born as a result of a great war or other period of hardship. The facts, if substantiated, would be of importance to eugenics, but Westermarck's handling of statistics is highly uncritical, and few outside of the profession are able safely to weigh questions of vital statistics. It is therefore of interest to have the opinion on this point of Prof. Walter F. Willcox, of Cornell University, one of the foremost American statisticians. Writing to the Syracuse *Post-Standard*, he said:

"It is common opinion among statisticians that the excess of males in the total births increases during or shortly after a destructive war. American birth statistics are meager and unsatisfactory and consequently we have little American evidence for or against the opinion. The only bit I know of is derived from Massachusetts, where the excess of male births during the five-year period of the Civil War was slightly greater than in any earlier or later period since 1850, as the following figures show:

Period	*Male births to 1,000 female*
1851–55	1,068
1856–60	1,063
1861–65	1,077
1866-70	1,065
1871–75	1,068
1876–80	1,065
1881–85	1,062
1886–90	1,058
1891–95	1,055
1896–00	1,057
1901–05	1,062
1906–10	1,056
1911–13	1,061

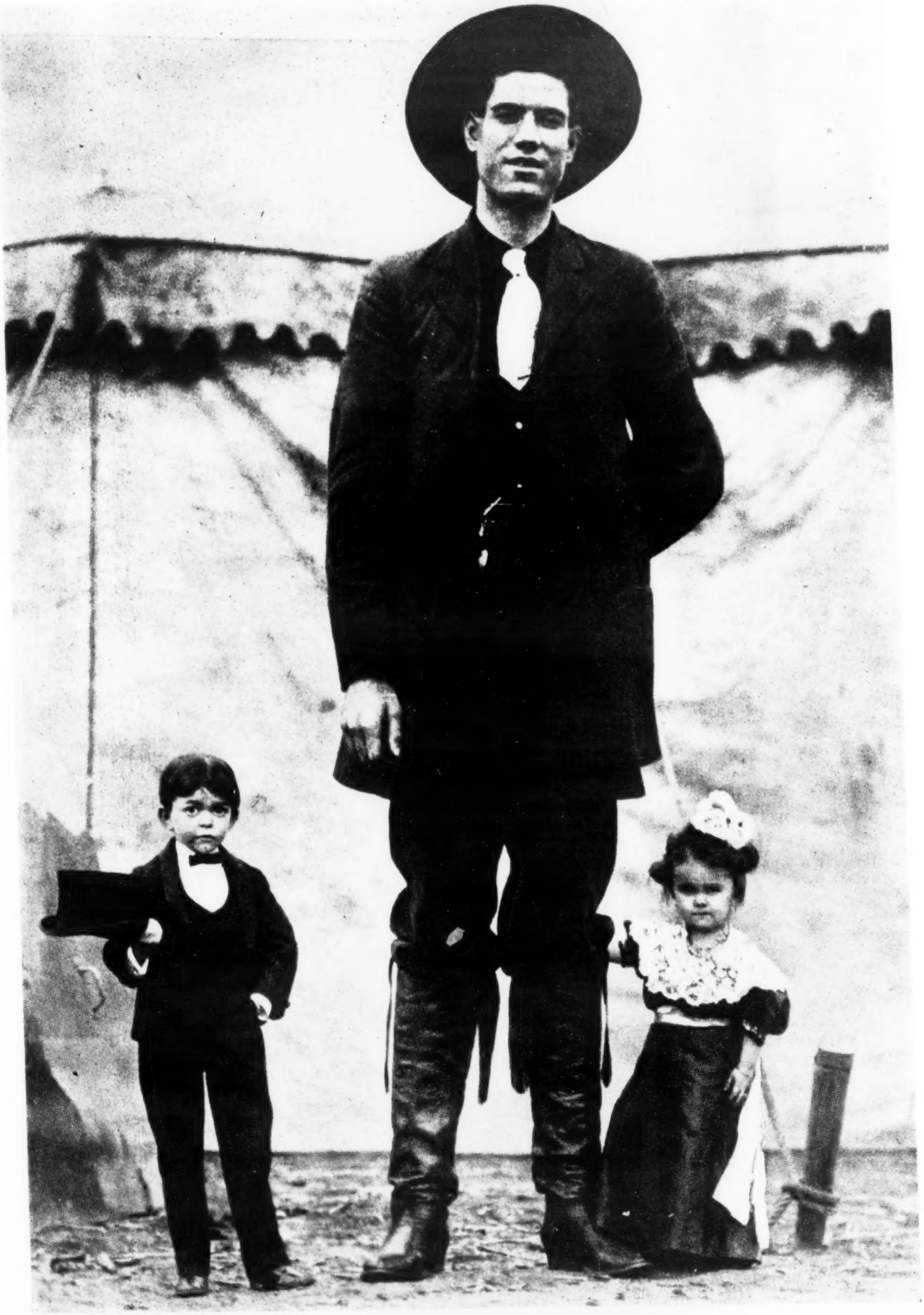
"Among European writers, von Oettingen wrote in 1882: 'The more the female population in any country exceeds the male as a result of any disturbing influence, the larger the proportion of males in the children born;' and von Mayr, a better authority, wrote in 1897: 'After wars apparently a larger proportion of male children are born.' Finally, in Prinzing's *Medical Statistics*, published in 1906, is the statement that 'after wars the excess of male children is said to increase. Düsing speaks of this as a well-known fact which has never been doubted and von Fircks shows it from the figures for Germany after the wars of 1866 and 1871.' But Prinzing adds that the increase did not appear in France after the war of 1871.

"The statistical evidence is too slight to demonstrate the existence of such an increase in the proportion of male children born after a war, but does make it possible, if not probable."

Foundation to Teach Mothercraft

Nearly a million dollars is left in the will of Mrs. Lizzie Merrill Palmer, widow of former U. S. Senator Thomas W. Palmer, to found a school where girls may be taught motherhood, according to the daily press. The will provides that girls unable or unwilling to pay the cost of their board at the school shall be educated free of charge. "I hold profoundly," says the will, "the conviction that the welfare of any community is divinely and hence inseparably dependent upon the qualities of its motherhood and the spirit and character of its homes." It is specified that the school be established in Detroit or the township of Greenfield, a suburb. Girls of ten years and upward will be admitted.

EXTREMES OF HUMAN STATURE



A giant and two dwarfs from a circus. Stature is made up of so many different items that it has been very difficult to analyze its inheritance. Mendelian writers are accustomed to say that cases of dwarfism in which all parts of the body are reduced proportionately (as in the two above) are a recessive to normal stature, but there are probably many different factors involved. Hereditary differences in some of the ductless glands of the body are thought to be, in part at least, responsible for great extremes of stature. Photograph from René Bache. (Fig. 12.)

WHAT GENETICS IS

"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."

To gain this knowledge is the object of the science of genetics, which proceeds, in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

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